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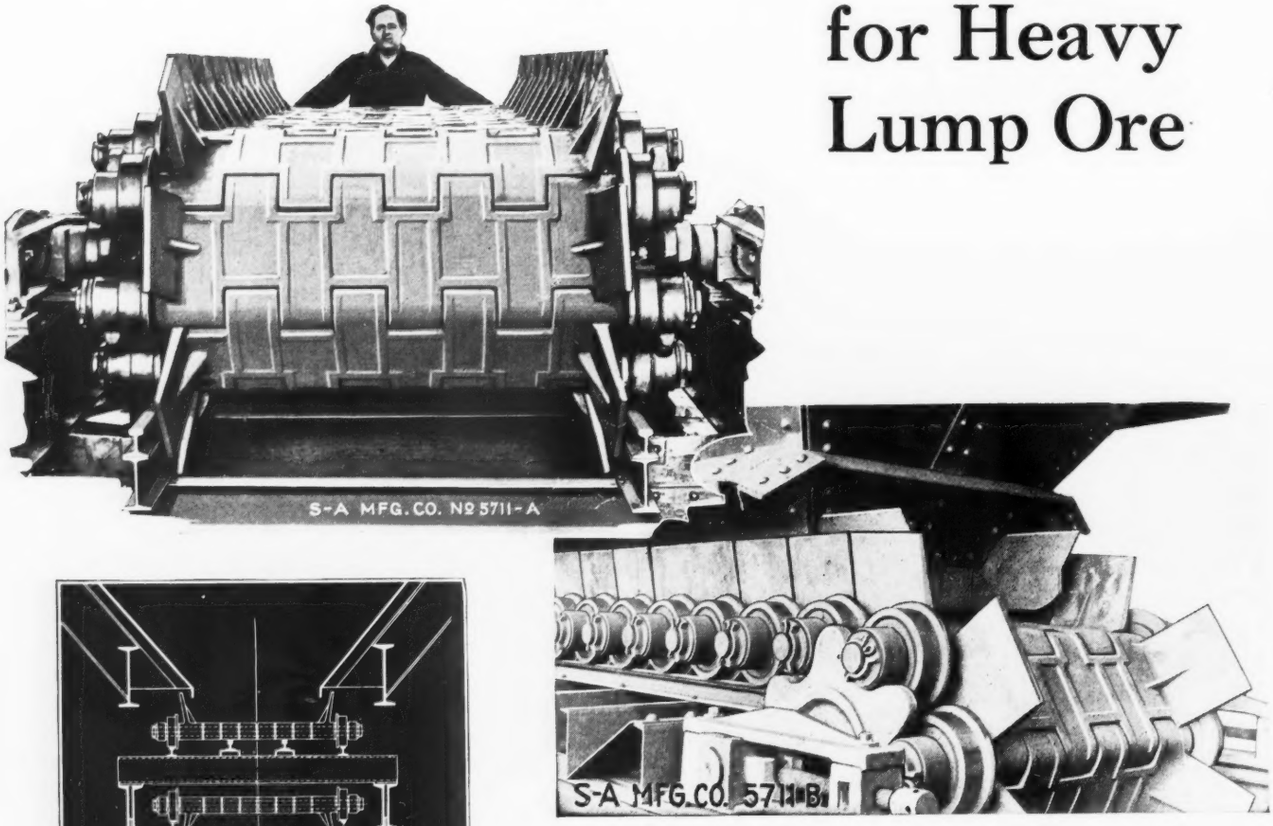
METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

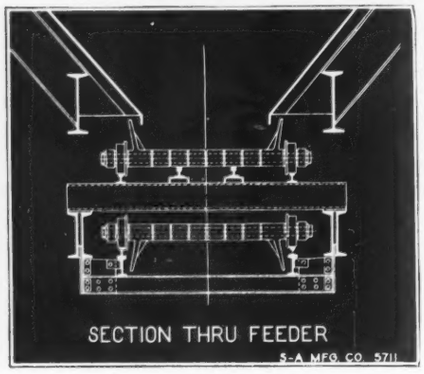
Tin Smelting Practice Today and Experiments in Carbon Reduction
By Colin G. Fink and C. L. Mantell

Sinking the Randfontein Ventilation Shaft

Theory and Practice in Selecting Grinding Media
By Harlowe Hardinge

S-A "Giant Type" Steel Feeders for Heavy Lump Ore





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Contributing Editor
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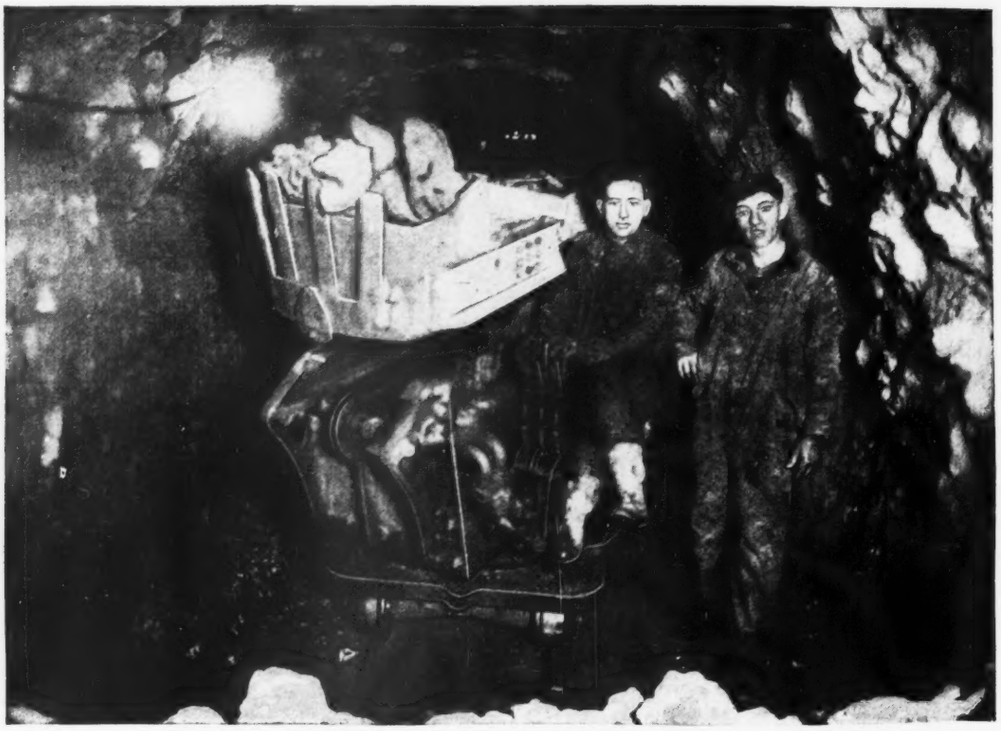
HOAR SHOVELS



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MINING JOURNAL

McGraw-Hill Publishing Company, Inc.
JAMES H. MCGRAW, *President*

A. W. ALLEN,
Editor

VOLUME 124 *New York, October 29, 1927* NUMBER 18

Research and Invention

FOOD FOR THOUGHT may be found in the opinions of Dr. Karl T. Compton, of Princeton, expressed at the Founders' Day exercises at Lehigh University, recently. Dr. Compton holds that the research worker is basically responsible for the discoveries that have provided the conveniences and luxuries of modern life, and that the inventor has merely turned these discoveries to practical account. He suggests that those industries which have benefited from such research should contribute liberally toward an extended program of similar basic investigation.

The contention is true and the deduction just. An invention is usually considered to be something patented or patentable, and a glance through the "Patent Office Gazette" will suffice to convince one that the great majority of inventors merely possess a certain ingenuity that enables them to modify existing discoveries to an extent sufficient to justify the legal interpretation of novelty.

Research is science. Patenting is business. A failure to combine the two has been the cause of poverty and disappointment among many brilliant and unselfish workers who have contributed largely to world progress. Michael Faraday, according to one of his biographers, abandoned thought of profit or monetary reward in return for the discovery that has since led to the most significant developments of this or any other age, because "worldly gains became contemptible in comparison with the rich scientific province he had subdued." Faraday's research gave rise to the greatest flood of inventive initiative and profit-taking the world has ever known. Industry has benefited by reason of a broader opportunity; and, as a consequence, mankind is given a degree of comfort and contentment that was absent in Faraday's time. The luxury of yesterday is the necessary of today. Endowment for research, therefore, is not philanthropy; it should be considered as merely an acknowledgment of a debt owing to the pioneers of a former generation and to their descendants in scientific endeavor.

Security and safety, as well as profit, have resulted from basic research; but it is not altogether correct to infer that the scientist is never an inventor. Humphrey Davy developed the miner's safety lamp after laborious research. He could have reaped a rich reward by patenting the idea, but he maintained that wealth could increase neither his fame nor his happiness. No expenditure to encourage present-day research can adequately memorialize the achievements of such great spirits in the domain of science.

A survey of the field of research and invention must comprise a study of the fundamental difference between the two. The vast increase in apparent novelties and minor improvements justifies the line of demarcation suggested by Dr. Compton. Invention, as we are learning to understand the word today, merely means the first step in an attempt to profit from the labors of research. The aim of the average inventor is to obtain protection of an idea that is usually built upon the most recent work of others in that field, the practicability of which is possible because of prior developments in that field and in many other fields. The research worker—the scientist—however, must go back to the beginning of thought and mental initiative, and build up a structure of logical reasoning as a preliminary to formulating a plan of action. Much of his work, therefore, is financially unprofitable and barren of immediate result; but with a sound foundation laid, he is capable of great achievement and is deserving of adequate financial and moral support.

Modern education might well teach more of the value of fundamental knowledge, logical deduction, and scientific research, instead of inferring to the extent it does that scholarship and culture may be gaged by evidence of success in memorizing.

Expansion and Diversification of Mining Properties

AMERICAN mining companies are showing an increased tendency toward the British custom of diversification of holdings in mining properties, not only securing properties in districts far removed from their main operations, but acquiring productive units for other metals than the one in which the home plant specializes. The St. Joseph Lead Co. is a good example. It has always been considered one of the chief lead producers of Southeast Missouri. It is now the leading producer there; but, further, it has large interests in the zinc-lead field of the Kansas-Oklahoma-Missouri district, and recently has acquired a lead mine in Montana and a zinc mine and mill in New York. It is thus an important zinc producer as well as a lead producer. Bunker Hill & Sullivan was formerly only a big lead-silver producer in the Coeur d'Alenes; now it also owns quicksilver mines, which will be enlarged, and through its ownership in the Sullivan Mining Co. participates in the production of zinc-lead ore from the Star mine. Through the Treadwell-Yukon Co. it has an interest in what promises to be an important lead-zinc deposit in northern Ontario. Hollinger, premier gold mine of America, is extending its interests into the copper-gold district about Rouyn, Quebec. Examples of this trend might easily be multiplied.

Although a small company is usually obliged by circumstances to put all its eggs in one basket, often not having enough eggs even to fill that, it would seem the

part of wisdom for a large and prosperous company to conduct an active exploration department, picking up and developing promising prospects regardless of their remoteness from the company's main property or of the kind of mineral; or to secure, by purchase, other desirable producing properties. The adoption of such a policy has several advantages. In the first place, it provides for the time when the original orebody will become exhausted, thus assuring continuity of operation for the company by an investment of funds at a time when such expenditure can best be afforded. In the second place, it insures against an economic depression in the market for any one metal. Further, it widens the experience of the operating staff, the solution of difficulties at one property often suggesting improvements that may be made at another. And for the mining industry, in a large way, such intelligent and well-considered development and operation are much to be preferred to the neglect, poor financing, and questionable promotion methods that fall to the lot of so many good prospects. By the adoption of such policies of extension and diversification of interests, mining companies will also come to be much more highly regarded by the investor in stocks. Their properties will not be considered in the light of a liquidating asset, and their securities will come to be regarded, as is Anaconda, more as industrials, with every likelihood that the company will continue in business for a long, long time.

The Pittman Act in Court

STANDING PAT in their refusal to order the completion of silver purchases required under the Pittman Act, Secretary Mellon and the Director of the Mint have filed an answer to the suit brought by the American Silver Producers' Association to compel them to make such purchases. Silver to replace all of the silver dollars melted down to supply bullion to Great Britain for use in India during the war has been purchased under the act, they say; and they deny that it is necessary to buy silver to replace what was used for subsidiary coinage, inasmuch as the allocations of silver for this purpose were revoked and the metal was subsequently returned to the silver-dollar account. Further, they assert that to force the Treasury to purchase 14,589,730 oz. of silver at $1 per ounce when the market prices is 55½c. would mean a gift to producers of more than six million dollars.

Thus the Treasury has not receded from the position held by it in the last few years. Doubtless it feels that through delay it will win. The silver producers were wise in taking the matter into court instead of leaving it to the mercies of another Congress. After all, as ex-Senator Thomas said last fall in Denver, the real question is whether a Secretary or Under-Secretary of the Treasury can interpret the law, the Pittman Act, as he sees fit, instead of in accordance with its provisions.

On the same occasion, Senator Thomas recounted the history of the Pittman Act and the subsequent transactions resulting from it, as reported in the *E. & M. J.* of Oct. 2, 1926. The matter of allocations of silver for subsidiary coinage he dealt with specially. As for the statement of the Treasury that the allocations were revoked, it brings to mind that nearly 11,000,000 oz. of the silver allocated was actually minted into subsidiary coins. How was it that the allocations were revoked? The explanation given is that these coins were later melted again and that the bullion was returned to the silver-dollar account. The legality of such procedure may well be questioned, for under the Pittman Act such allocations were to be regarded as actual sales, calling for replacement by an equivalent amount of silver purchased at the dollar price.

The Secretary and Director Grant now raise the cry that to complete the silver purchases in accordance with the law would be equivalent to making a gift to the producers from public funds. Here again they would ignore the law. It was strictly in accord with the text and intent of the Pittman Act that the Treasury should pay $1 for silver purchased under its provisions when the metal was cheaper on the open market. Anyone who understands the law and the reason for enacting it will realize that this was just.

Engineering and Mining Journal Copper Quotations

DURING periods when the copper market is dull—as it has been recently—discussion frequently is heard as to how closely the weekly average of copper quotations, determined and published by *Engineering and Mining Journal,* agrees with the *weighted* average price realized by sellers during the week. Everyone familiar with the situation agrees that the day-to-day figures are as nearly exact as can be, bearing in mind the fact that they cannot be determined entirely by mathematical calculation. The market editors have definite information as to the quantities and prices involved in the sale of at least 95 per cent of the electrolytic copper sold in the domestic market. The daily quotation is, in effect, a weighted average price.

However, many smelter contracts specify that settlement shall be made on the basis of the *Engineering and Mining Journal* average for the week in which the day of settlement is included. For the convenience of all concerned, the arithmetical average of the daily quotations is calculated and published. It is contended frequently that, in periods when markets are dull, this average does not coincide closely with the price that the sellers realize for refined metal; in other words, that they sell a larger tonnage when the price is either very low or very high. It is reassuring that some maintain that the method operates to the disadvantage of the shipper of custom ores to the smelter, whereas others feel that the tendency is for the quotations to be on the high side, thereby obliging the smelting companies at times to pay more for copper purchased than they can get for it. That there will be some deviation between the arithmetical average for a week or a month and the figure that would be obtained if all the sales of the same period were weighted as to tonnage and price, is doubtless true—especially when a considerable spread in prices has prevailed and when the great preponderance of tonnage has been sold on certain active days. It has always been our belief, however, that over a period of six months or a year these irregularities would compensate, and that neither the smelting companies nor the shippers of custom ore would suffer.

With the purpose of verifying this conviction a comparison of prices for the last fifty-two weeks has been made. An arithmetical average of the weekly averages is 12.983c. per pound; this represents what a mining company shipping at a reasonably uniform rate would realize for the copper in his ore, subject, of course, to

the usual deductions, which would be the same in any case. A second calculation has been made by weighting each weekly average price, as published, according to the total sales for the corresponding week as reported to us by the selling agencies. The result is 12.996c. per pound, which represents the average price realized by the sellers of refined metal to consuming industry. The discrepancy between these two prices is only slightly more than one one-hundredth of one cent. Apparently the shippers of ore have the worst of it to this extent; but it is likely that in other years they have been favored.

It is evident that these calculations do not take into account any discrepancies that may arise in the determination of the weekly figure by the averaging of the daily quotations. However, total sales by weeks during the period under consideration ranged from nearly 50,000 tons to as low as 1,500, and the prices varied much more widely than in any one week. Consequently it is reasonable to conclude that similar fluctuations in day-by-day data will be compensating. Calculations for various weeks for which the detailed data are available show that the weighted average at times has been higher and at other times lower than the arithmetical average. Despite irregularities, the net result seems to be the provision of an entirely equitable basis for the sale of ores.

Where to Prospect?

WHERE TO PROSPECT is a pertinent question, the answer to which is based largely upon opinion; but recent developments indicate that prospecting within and in close proximity to known mining districts is of increasing importance, exemplified by the discovery of the North Lily orebody within the heart of the Tintic district and of the Campbell orebody in the Junction mine, at Warren, Ariz. Mr. F. W. Bradley has reopened the old Sulphur Banks quicksilver deposit, and likewise has been successful in discovering an orebody in the Star mine, near the Morning mine, at Mullan, Idaho, and an important deposit in the Sudbury district. The United Verde company has reopened a prospect in the Oatman district. Utah Copper is investigating areas in Bingham Canyon. The Phelps Dodge company is prospecting from the Warren shaft, and the United Verde Extension is doing likewise in the Gypsy Queen shaft, Bisbee district. Calumet & Arizona is sponsoring an exploration in the Verde Central, in the Jerome district. Tonopah and Leadville have extended their life and mineral areas by persistent exploration. Other examples could be mentioned, but no further evidence is needed to emphasize the importance of existing mining districts as significant areas for exploration. Not all exploration in these districts can be successful, and many old districts will never be revived; but the possibility of successful exploration is all the greater if thorough geological studies are made in advance. That new mining districts will be discovered is a foregone conclusion; but the intensive searching that has taken place in the last seventy-five years restricts the scope of such discovery. Likewise the repeated examination of known prospects has limited the possibility of discovery from surface showings; the mining geologist must decide if they warrant exploration. The detailed work done on outcrops and the availability of electrical methods for preliminary work extend the scope for geological investigation. Co-operation between the mining geologist and the mining company continue to be essential.

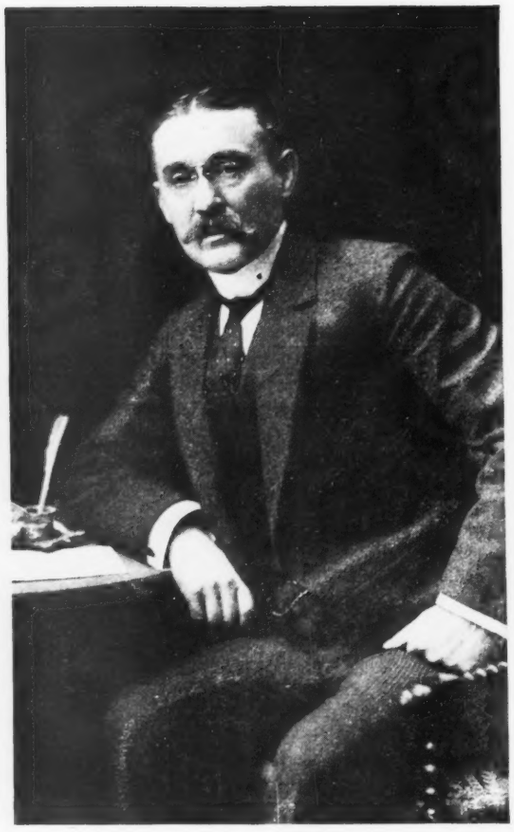
Effect on Navigation of California Hydraulic Mining

THE SECTION on Harbor Development of the Commonwealth Club of California favors the resumption of hydraulic mining in that state, provided reasonable safeguards, such as the permanent maintenance of the débris-restraining dams, be assured. Mr. H. W. Crozier, at a recent meeting, was of the opinion that the impounding of gravel and other débris would be wholly beneficial to navigation, and that the provision of the dams would result in a reduction of the volume of water at the peaks of flood discharge, and in an increase of the water available when the flow was normally scanty. Mr. C. E. L. Grunsky, brought out an interesting point, contending that, if hydraulic mining were allowed to proceed until the débris capacity of the dams was reached, a dangerous condition would result, in that it takes several years for most of the gravel to move from the seat of hydraulic operations, down the drainage channels, to the reservoir behind the dam. It would be wise, therefore, if mining operations were stopped before the débris reservoir were actually full; and Mr. Grunsky suggested that a reasonable limit might be set by restricting the amount of ground to be hydraulicked and proportioning it to the storage capacity behind the dams.

Mr. Grunsky's contention is sound, and its logic is generally conceded by those interested in hydraulic mining. The significant point brought out at this meeting, however, is the fact that restraining dams on watersheds feeding navigable rivers and bays would be of benefit to navigation. Thus one obstacle—less formidable, however, than that offered by the agricultural interests—appears to have been removed. A careful and unbiased investigation of the claimed disadvantages to agriculture should go a long way toward meeting the farmers' objections.

Lead and Ethyl Gasoline

THE INCREASED PUBLICITY given to the use of ethyl gasoline causes some to think that perhaps herein lies a new outlet of importance for lead. That no such possibility exists, however, was pointed out in these columns two or three years ago; but perhaps the matter may be explained briefly again, in the light of more up-to-date data. In every 1,300 gallons of ethyl gasoline there is approximately one gallon, or 14 lb., of lead tetraethyl, containing about 9 lb. of elemental lead. Present consumption of ethyl gasoline is not known, but an estimate of 750,000,000 gal. a year is sufficiently accurate for this purpose. This would represent ar annual consumption of lead in the United States, for making ethyl gasoline, of approximately 2,500 tons, or one-third of 1 per cent of total domestic lead production. Even if all the gasoline that is used in the United States were thus treated—say 12,000,000,000 gallons a year—only 6 per cent of the country's lead production would be required. So the lead miner with an automobile cannot improve his market much by buying ethyl gas: he would do better to paint his house with a pure lead paint, have nothing to do with battery eliminators for his radio set, and insist that his power be brought along the street to him in lead-incased cables.



Charles M. Rolker

An Appreciation by Thomas H. Leggett

ANOTHER of the Old Guard and one of the pioneers in the early stages of the mining development of our great West, has crossed the Divide. Charles M. Rolker died on October 14 in his seventy-sixth year after a long and painful illness, endured with characteristic fortitude and cheerful patience.

Born in Brooklyn, New York, in 1852 he obtained there his early education; then studied for two years, 1868-70, at the Royal Academy, Clausthal, Germany, after which he spent two years in practical work in the iron mines of New Jersey and Lake Superior and in Wisconsin lead mines. So when in 1872, at the age of twenty, he entered Columbia School of Mines his intellectual vision was focussed. He knew what he wanted and needed, and when he graduated in 1875 with the degree of Engineer of Mines he was well equipped for his subsequent brilliantly successful career, first as mine manager, then examining engineer, and finally as a consulting engineer of international reputation.

His first position as assayer at the Allouez mill, Lake Superior, was relinquished to take that of mining engineer to the Mariposa estate in California, after which he was superintendent of the Emma mine, Nevada, the Stormont Silver Mines, Utah, and finally general manager of the famous Chrysolite mine, at Leadville, from 1880 to 1882. Then for nine years he was in general consulting practice with office in New York, during which period he examined and reported upon mines in the United States, Mexico, Central America, and the East Indies, confining his work to gold and silver deposits and the base metals other than iron. During this period, while examining a mine in the West, he was accompanied underground by the owner, who offered him a considerable sum should his report result in the purchase of the property by his principals. On his way east Rolker telegraphed the man, requesting a wire from him giving the amount and other details of the proposition to refresh his memory, as he had made no note of them at the time, and received the reply at the designated station on the railroad, thus securing the necessary proof of the offer. Rolker's sterling integrity was an outstanding characteristic, but he was possessed also of the acumen needed to bring the guilty to book.

He was always a most keen observer and little escaped him of mineralogical or geological value. As an instance, when in Honduras he noticed some weathered shales alongside the trail. Dismounting, he soon uncovered some fossil plant impressions which Professor Newberry determined to be a new species of Cycad and thereupon named it the "Zamites Rolker."

In 1891 he was appointed consulting engineer to the British South Africa (The Chartered) Company, and in that and the following year he made a long trip through the then Mashonaland portion of Rhodesia, Lord Randolph Churchill and Dr. Jamieson being with him most of the time. While obliged to disappoint the exaggerated hopes of the early Mashonaland pioneers, the future of the country bore out in a large measure his report, discouraging though it was in some respects and for which he suffered much criticism. But in this regard the best compliment that could be paid him was given in 1904 by the late Mr. Alfred Beit, then one of the Chartered Company directors, who commissioned him to make a report on the resources of Rhodesia north of the Zambesi, to guide them in determining the course to pursue in the opening up of the country, and it was largely on Mr. Rolker's recommendation that it was determined to push the extension of the railroad north of the Zambesi.

After the first trip into Rhodesia Mr. Rolker was obliged to resign and return to the States, having contracted there a severe case of neuritis, which disabled him for over a year. In 1895 he was again called to England, this time to take the management of the Mining and Financial Trust Syndicate, Ltd., with which he was connected for three years, when he resigned to open private offices in London, as consulting engineer.

His duties as manager of the Syndicate sent him to Australia and to the Rand, and during the Jamieson Raid he was in Cape Town, whence he added his voice to those of many others raised on behalf of the American prisoners in Pretoria. Not knowing President Cleveland personally, he cabled the Hon. Abram S. Hewitt, requesting him to endeavor to prevail on the President to send a friendly message to England in view of the existing Transvaal complications. Such a message was in due course sent.

It was on Mr. Rolker's report and advice that a group of English capitalists bought the controlling interest in the Lenskoie (called "The Lena") Gold Placer Mines in Siberia about 1,000 miles north of Irkutsh, the great success of which undoubtedly gave additional stimulus to the inflow of British capital into Russian mines in the early part of the present century. He continued in active practice in London until the latter part of 1918, when he returned to New York, retiring from further work.

From early youth, his was a strong and positive character. While manager of the Chrysolite mine, in Leadville, he was the moving spirit to oppose the collection of the dividend tax on the ground that the Legislature had not provided the machinery called for by the state Constitution for the collection of the tax.

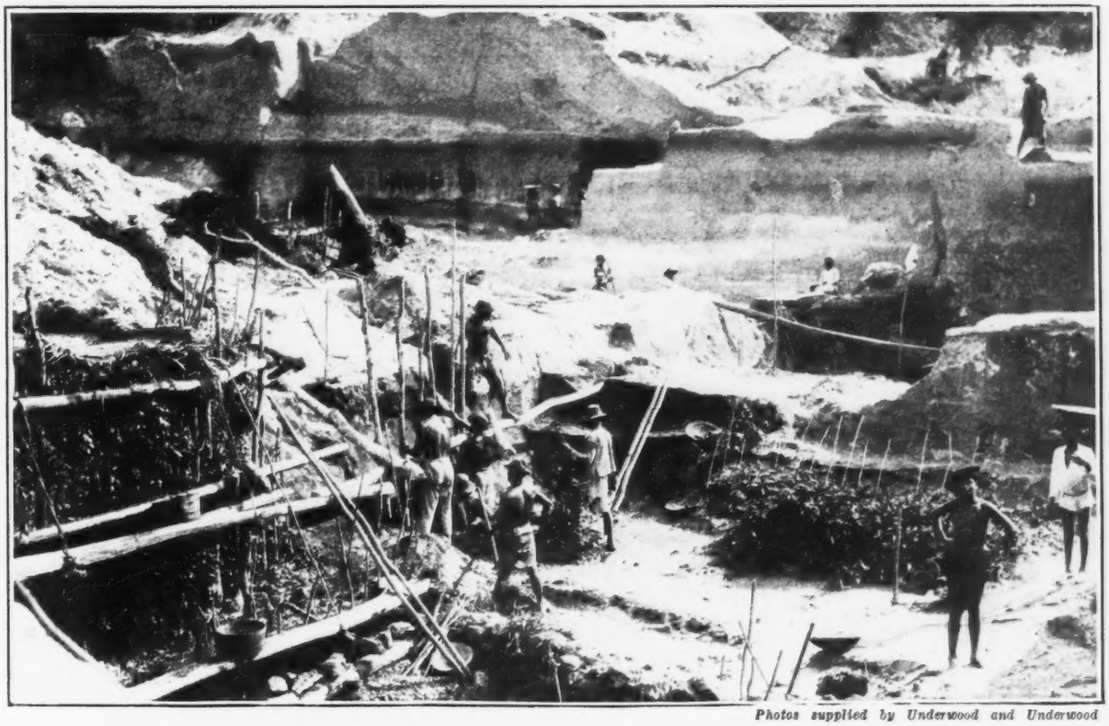
Charles M. Rolker's professional standing was so high and his probity so thoroughly recognized that he was repeatedly appointed referee in important mining disputes both in and out of court. In his earlier years he contributed frequently to the *Transactions* of the American Institute of Mining Engineers, of which he was a member, and he served for some years on the Board of Managers; while in London he was a member of the Council of the Institution of Mining and Metallurgy.

His was the professional mind, "par excellence"; the conscientious and thorough fulfillment of his duties and responsibilities as adviser to important interests, his chief aim; the exhaustive investigation and study of the problems involved, his joy and delight; and so to him, as to all such, financial gain was always of secondary importance.

He leaves a wife and two daughters; and although the circle of his contemporaries has grievously narrowed in recent years, many friends still remain to mourn his passing.

In the Piranhas Diamond District, Brazil

Black diamonds (carbons), used in drills, are sought here. The productive gravel, or "cascalho," is reached after the overburden has been removed by the slow process of manual labor, supplemented by the "carumbe," or wooden bowl, seen in these illustrations. The gravel is concentrated by screening and hand sorting, the finest sizes being handled in the "batea," as depicted on this week's front cover



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Tin-Smelting Practice Today

AND

Experiments in Carbon Reduction

First of a Series of Articles Based on Physico-Chemical Studies in the Metallurgy of Tin

By C. G. FINK and C. L. MANTELL

Respectively, Head, Division of Electrochemistry, Columbia University, and Consulting Chemical Engineer, Pratt Institute, Brooklyn

PRACTICALLY the only source of primary tin is the stannic oxide ore, cassiterite. The winning of tin from its ores consists essentially of causing the conversion of the stannic oxide, SnO_2, to elemental tin. This can be accomplished in a variety of ways, only one of which is now in commercial use and of present economic importance.

Stannic oxide can be reduced by carbon at fairly high temperatures. It will be shown below that the mechanism of the reaction takes place between a gas phase (the partially oxidized fuel, thus gasified) and a solid phase (the ore) and not between two solid phases. Cassiterite can be reduced to tin metal by certain reducing gases, such as hydrogen and carbon monoxide; commercial gases containing these or mixtures of them; or at a lessened rate by hydrocarbons and gasified oils.

The possible metallurgy of tin divides itself naturally into several subdivisions by following through the analogy of other non-ferrous metals:

REDUCTION OF SnO_2 TO Sn

A—Reduction and removal of oxygen:
- 1—By carbon and related solid reducing agents.
- 2—By gaseous reducing agents, as:
  - (*a*)—Hydrogen.
  - (*b*)—Carbon monoxide.
  - (*c*)—Hydrocarbons.
  - (*d*)—Commercial reducing gases.

B—Leaching of the ore (as in the case of copper) with direct separation of the metal from the leaching liquors.

C—Converting stannic oxide to a soluble form and decomposing the compounds formed.

D—Solution and decomposition in a fused salt bath (as the Hall process for aluminum).

E—Electrolytic reduction at the cathode in aqueous solutions.

F—Reduction of cassiterite by metals.

G—Combinations of the above methods or combinations of parts of the above methods.

Also, in addition to the above, the tin metal produced may need refining. This adds another subtopic:

H—Refining of tin metal:
- 1—Electrolytically:
  - (*a*)—Alkaline baths.
  - (*b*)—Acid baths.
  - (*c*)—Complex ion baths.
- 2—Metallurgically:
  - (*a*)—Liquation.
  - (*b*)—Drossing, or other means.

Tin-plate scrap is a relatively important source of tin metal, as 3 per cent of tin metal comes from this source. This adds another subtopic:

I—Detinning.
- 1—Electrolytic:
  - (*a*)—Alkaline bath.
  - (*b*)—Acid bath.
- 2—Chlorine gas.
- 3—Other methods.

ORES OF TIN

Tin is a metal of great antiquity. It is highly probable that the earliest tin ore-dressing operations were applied to alluvial tin deposits and that the working of lode deposits is comparatively modern. The principles employed, however, are essentially the same as those used in ancient times. Tin ores occurs almost invariably as cassiterite, which is largely stannic oxide. A complex sulphide, or tin stannite, or bell-metal ore, consisting of the sulphides of tin, copper, iron, and occasionally of zinc, is known, but is a relatively rare mineral, and as a result cannot be considered as an ore. Cassiterite is found either in veins or in alluvial deposits called stream tin. In the latter form it is usually very pure, because cassiterite itself is a very inert material, mechanically inactive and with a high specific gravity; the accompanying minerals having been disintegrated, decomposed, and washed away by the action of the atmosphere and water, the cassiterite alone remains unattacked. Vein deposits are always granitic or else the deposits are closely related to dikes or masses of granitic rock in their vicinity.[1] The accompanying minerals are, therefore, usually quartz, feldspar, and mica. Other accessory minerals, such as tourmaline, topaz, fluorspar, apatite, iron, arsenical pyrite, wolframite, and copper pyrite, also occur some of them often being closely associated with the tinstone.

The largest supply of tin is found in the Malay Peninsula in the East Indian Islands adjacent to the Straits of Malacca. The deposits are chiefly of stream tin. In Australia both stream and lode tin are found, the chief brands being Mount Bischoff and Pyrmont. In Cornwall, England, tin veins have been mined from the time of the Romans, these being long the source of the

[1] W. G. Jones: "Tin Fields of the World." P. 54.

world's supply. Great Britain now leads in the modern methods of tin and ore smelting.

In recent years, as a result of the decreased production of the Cornwall mines and the depletion of other fields, as well as of the increased world consumption of tin, Bolivia has come to the fore as one of the producers of tin ore. Bolivian ore, however, because of its complex nature and chemical combinations, causes many difficulties. Africa produces tin ore in the Transvaal, Swaziland, and Nigeria. The United States itself produces practically no tin ore, in recent years the greatest domestic production having come from Alaska, which, however, at its maximum output produced only 600 tons annually. Some of the oldest tin mines occur in Saxony and Bohemia, where, however, the metallurgical operations are of the crudest. The Bohemian tin mines are almost completely exhausted.

Tin as an element forms less than 0.001 per cent[2] of the igneous rocks of the earth's crust, and only a small percentage of the world's granitic masses are stanniferous.

Commercial Tin Smelting

The only American book on tin metallurgy in the last twenty-five years is that of Henry Louis—"Metallurgy of Tin." In his preface in 1911, Louis says:

> This little work is in the main a reprint of a monograph on the metallurgy of tin, published originally in "Mineral Industry" for 1896, Vol. V. Authentic information on the subject of tin smelting is somewhat scarce, and as the above-mentioned volume has long been out of print, it was decided to issue the monograph as a separate work, incorporating in it as much recent information on the subject as was available. The small amount of new matter is due to two reasons: firstly, the unprogressive character of tin smelting, which continues from decade to decade with comparatively little change, and secondly, the profound degree of secrecy observed by tin smelters, who are extremely anxious to keep to themselves any modifications or improvements in processes. These two facts, the slow advance of the industry, and the secretive habits of those engaged in it are related as effect and cause.

Until the World War period, the chief improvements in practice originated in the Pulo Brani Works of the Straits Trading Co. These works produce 30,000 to 50,000 tons per year. There is no doubt that they constitute one of the main reasons why tin metallurgy has not kept pace in any measure with that of other common metals. Tin is by far the rarest. Comparing the world's annual output of the common metals in 1926—copper 1,628,000 tons, lead 1,759,000, zinc 1,377,000 tons, aluminum 220,000 tons, and tin 159,000 tons—the difference is sufficiently striking. It must be remembered that several individual copper, lead, and zinc plants produce more than 100,000 tons a year, close to the total annual tin production. When metallurgical operations are conducted on a small scale, they are more likely to be surrounded with secrecy. In consequence, improvements come slowly, and ancient methods survive with surprising tenacity.

The only source of primary tin is the stannic oxide ore, cassiterite. This mineral is found in two forms differing in their mode of occurrence—namely "vein tin" and "stream tin." "Vein tin" is the ore from primary deposits—that is, mineral veins, lodes, stockworks, or disseminations. "Stream tin" is the ore in rounded lumps or grains obtained from secondary alluvial deposits, resulting from the disintegration of primary deposits through weathering. The extremely hard, heavy, and chemically inert cassiterite has resisted the natural agencies which destroyed the other minerals. "Vein tin" in comparison to "stream" ores is a very impure material.

If the smelter has only one ore to deal with, the metallurgy of tin is comparatively simple. Its reduction in practice is almost invariably accomplished by the aid of carbonaceous materials. Several complications occur however: (1) The temperature of reduction is so high that the oxides of other metals, present in a greater or lesser degree, are reduced at the same time. These metals may produce undesirable and troublesome tin

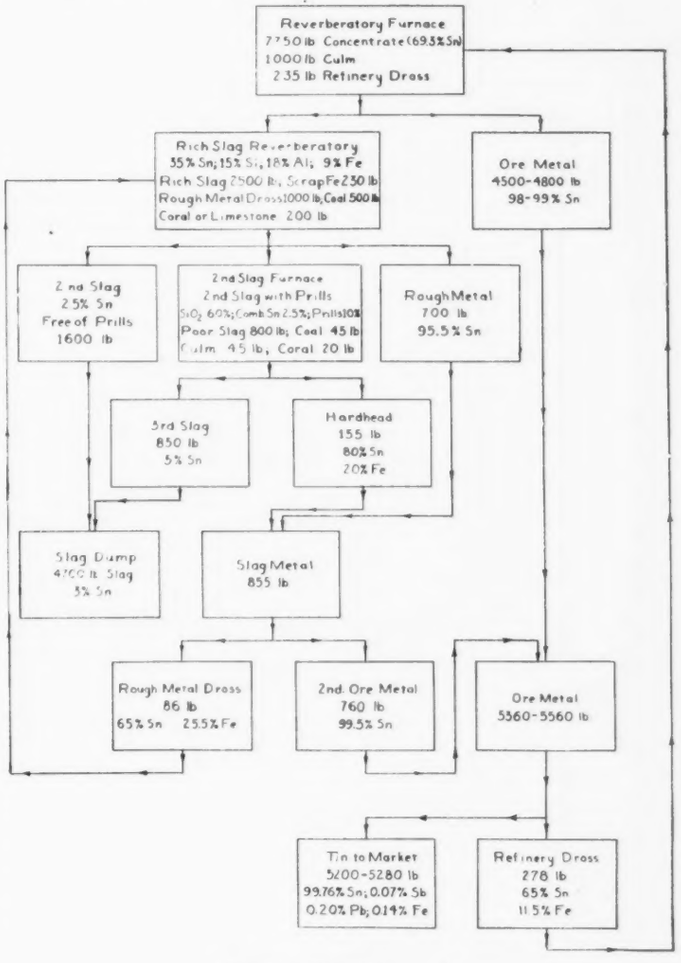


Fig. 1—Straits practice

alloys. The iron-tin alloy, "hardhead," is an example. (2) Tin oxide is amphoteric. Unless conditions are carefully regulated, the furnace linings are attacked. Siliceous acid linings cause tin silicates to be formed; basic linings of lime or magnesia result in losses as stannates. (3) Tin metal at elevated temperatures is more fluid than is mercury at ordinary temperatures. It finds the most minute openings for escape and soaks into the porous refractories of furnaces to an amazing degree. (4) The slags produced contain appreciable quantities of tin. This metal must be recovered. Slags require further treatment also; there may even be treatment of successive slags for their tin content. Part of the tin in the slags is present mechanically retained as "prills," or small metallic globules.

There are therefore three stages in the smelting of tin ores or concentrates. (1) Reduction, or tin smelting

[2]Clarke and Washington: U. S. Geological Survey Professional Paper No. 127, 1924.

proper; (2) cleaning the slags and furnace linings and recovery of tin from them; (3) refining the impure tin.

One of the most eminent smelters in the world is the Pulo Brani works of the Straits Trading Co. This plant

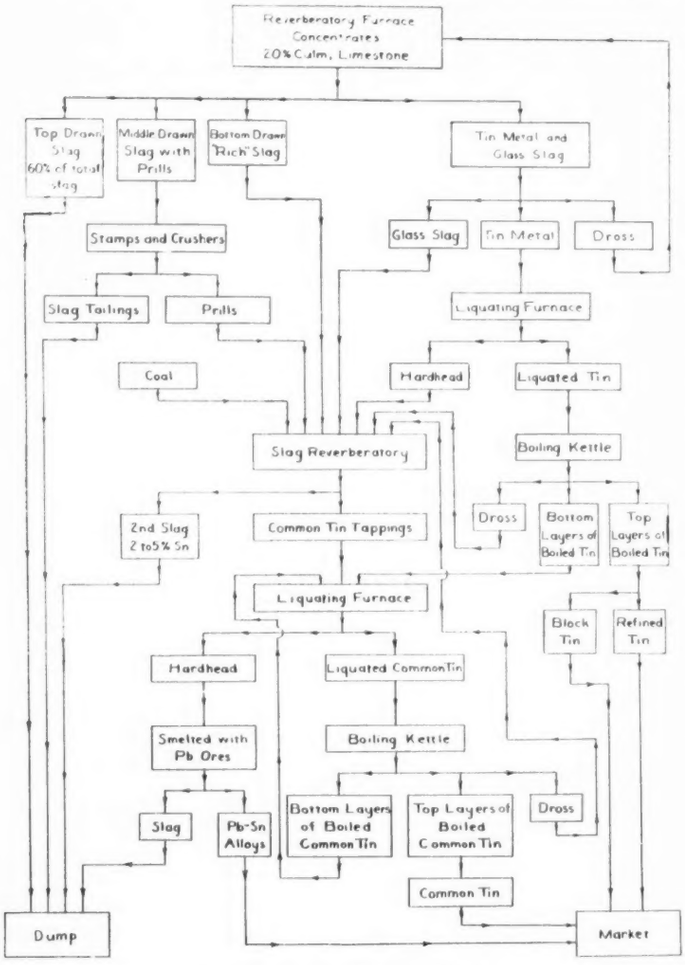


Fig. 2—Cornish practice

is located off Singapore, Straits Settlements. A process and tonnage flow sheet of the operations is given (Fig. 1). Reverberatory smelting furnaces are used, a special feature of the furnace being the water vault. The lower part of the furnace foundation below the ground line is built so as to form a water tank the full length of the hearth and the length of the holding kettle. Eight feet depth of water is maintained. Any tin leaking through the furnace bed or through joints drops into the water and is thus granulated, this material being collected periodically. As it is absolutely impossible to prevent leakage of so mobile and easily fusible a metal as tin, this water vault presents to the smelters a satisfactory method of handling leakage and recovering the metal.

Straits practice is summed up in the following operations: Alluvial concentrates are smelted with carbonaceous material to produce "ore metal" and "rich slag" high in tin. The rich slag is smelted with the aid of coal and scrap iron to produce "rough metal" and "poor slag." The "poor slag" is smelted for prills, producing "hardhead" and another low-grade slag which is sent to the dump. "Hardhead" and the rough metal, together making the "slag metal," are refined, the dross returning for reprocessing, the refined slag metal joining the "ore metal." The total metal recovered from the concentrates is refined by liquation, poling, or tossing. It is stated that in continuous operation 97 to 98 per cent of the metal present in the original concentrates is recovered. The iron consumption amounts to about 5 per cent of the tin produced, and the coal consumption 25 to 30 per cent. Concentrates run from 65 to 70 per cent or better in tin. They are of alluvial or "stream" origin, thus being very pure.

Cornish practice is shown in the second flow sheet. It differs from Straits practice in that ordinarily iron as raw material is not used to replace tin in the slags as a method of recovery. The slags are subdivided to a greater extent and a greater number of varieties of tin are produced. Cornish smelters have to use vein Bolivian ores, diluted with alluvial concentrates. Furnace liquation is used in Cornwall more often in the treatment of the impure tin metal produced. Concentrates are mixed with 15 to 20 per cent of culm, a small amount of lime as a flux, and often some slags, drosses or other tin-bearing products from other stages of operations. The materials are mixed and dampened before charging into the furnace. Furnace temperatures are of the order of 1,200 to 1,300 deg. C. After rabbling and settling, about two-thirds (the upper two-thirds) of the slag is withdrawn and sent to the dump. Another portion is reworked by stamping and crushing for prills. The slag tailings go to the dump, the prills being reworked with the remainder of the slag, which contains appreciable tin in the combined form.

Tin metal from reverberatory smelting is cast into molds, the "glass" slag with it being removed and sent to the slag furnace. The cast tin is liquated, the "hardhead" going to the slag furnace for reworking. The liquated tin is "boiled" by poling with billets of green wood or admitting air under pressure, and the heavy impurities are allowed to settle out. The top layers of the boiled tin are cast into molds, and, depending upon the purity of the metal, sold as refined tin or as block tin. Drosses return to the concentrate smelting furnace for reworking; the lower layers from the boiling kettle are mixed with the metal recovered from the slags and other products. The slags containing appreciable tin, the prills, "hardhead," and glass slags are treated with some culm in the slag reverberatory. The resulting slags, running from 2 to 5 per cent of tin, are discarded. Metal tappings from the furnace are cast into molds and liquated, the liquid is boiled, and the top layers are cast into molds and sent to the market as common tin. The bottom layers are returned to the slag reverberatory, along with the drosses, for reworking; and the "hardhead" produced from liquation is either discarded or smelted with antimony or lead ores to produce antimony, tin, or lead-tin alloys which can be disposed of as such.

American Tin-Smelting Practice

The refining by furnace methods is at best an imperfect operation, for large quantities of impurities cannot be separated. The quality of the tin produced depends very largely on the original purity of the concentrates. American tin-smelting practice, when plants existed in the United States for the treatment of foreign tin ores, was more advanced than any others so far developed. In 1903 R. T. White, in Bayonne, N. J., built a plant for the International Tin Co. to smelt Straits of Malacca concentrates. The British government then placed a 40 per cent ad valorem export duty on tin ores to other than

British smelters, so the plant failed, owing to lack of raw material at a price which would allow the enterprise to continue. In 1915, tin shortages in the United States, and the availability of Bolivian vein ores, again made possible the establishment of tin smelters,

The flow sheet of the Maurer plant of the American Smelting & Refining Co. is given in Fig. 3. This plant treated Bolivian ores exclusively. The material termed "ore" is a concentrate containing between 55 and 65 per cent of tin, with arsenic, antimony, iron, copper, tungsten, bismuth, lead, and sulphur as impurities. The ore was given a preliminary roasting in a Wedge furnace to drive off sulphur by oxidation and antimony and arsenic by volatilization. The ore from the Wedge furnace was mixed with blast-furnace dust (recovered in the baghouse) in a mechanical mixer. It passed on to a Dwight & Lloyd sintering machine, where it was sintered with lime and sometimes silica. Lime was added to the sinter charge to protect the grate bars of the machine and also for fluxing the sulphur remaining in the ore. The sintered ore passed to the blast furnace, where it met drosses from various operations, coke, and the fluxes or slag-forming materials.

Special care had to be taken in proportioning the slag so as not to get it too basic, under which condition the tin compounds in the ore formed stannates and were lost in the slag; and not too acid, under which conditions tin silicates were formed and lost in the slag.

The best proportions of the slag components were found to be 38 to 40 per cent silica, 22 to 28 per cent iron oxide (FeO), and 38 to 40 per cent lime, magnesia, and alumina. An average slag in good tin-smelting practice was about 33 per cent silica, 28 per cent iron oxide, and 28 per cent lime. Finished slags were of about the following percentage composition: SiO_2, 35 per cent; FeO, 18; CaO, 28; Sn, 2.8 to 2.5; and the remainder, MgO and Al_2O_3.

Very good slags, metallurgically speaking, were 3:4 sesquisilicates.

In the blast furnace the stannous oxide, when produced, acted as a basic constituent, whereas the stannic oxide acted as an acid one. It is interesting to note at this point that the stannous sulphide was volatile at 1,075 deg. C., whereas the temperature of the blast might go as high as 1,400 deg. C.

In practically all plants the first slag produced from the blast furnace contains such large quantities of tin that it must be re-treated practically as if it were an original ore. At the Maurer (New Jersey) plant it was claimed, however, that better than 90 per cent of the tin in the original ore was recovered and that there was little volatilization of tin compounds.

In the Maurer flow sheet, the blast-furnace produces a crude tin which goes to the liquating furnace; and a high tin slag running 6 to 10 per cent tin, which is sent in the molten condition to the slag reverberatory. Fumes from the blast furnace are collected in the baghouse, returning to the process by mixing and sintering with fresh ore. The slag, at 1,100 deg. C., is raised to about 1,300 deg. in the slag reverberatory and treated with lime and coal. It is then settled. Tin metal produced is either sent to the liquating furnace, joining the tin from the blast furnace, or is placed in the casting kettle for casting into anodes. The slag from the reverberatory, containing 2.0 to 2.8 per cent tin, is sent to the dump. Slag-pot skulls go to waste. Iron-tin alloy, or "hardhead," returns to the blast furnace.

The crude tin from the blast furnace is liquated and then cast into anodes on a continuous anode casting wheel. Dross, alloy, and scrap return to the blast furnace. The anodes are sent to the electrolytic refinery and refined in a manner almost identical with that for copper, using lead-lined tanks and a sulphate-fluosilicate electrolyte. The product, ready for market, is 99.8 per cent tin.

The anode slime, which, in the refining, in contradistinction to copper refining, clings to the anodes, is washed from the anode scrap, and worked up for bismuth, and in some cases for arsenic, antimony, lead, and other constituents. Anode scrap is returned to the anode furnace for recasting into anodes.

Electrolytic tin is lower in impurities than any of the foreign brands of tin. It is claimed that an average of three-fourths of a ton of slag was produced per ton of 60 per cent concentrates smelted. The tin loss in slags was from 1.5 to 2.5 per cent of the tin. Electrolytic refining losses were 10 lb. per ton of 97 per cent tin anodes refined. Tin recoveries were of the order of 94 to 97 per cent of the metal originally charged as concentrates.

At present, all the American smelters are closed, as

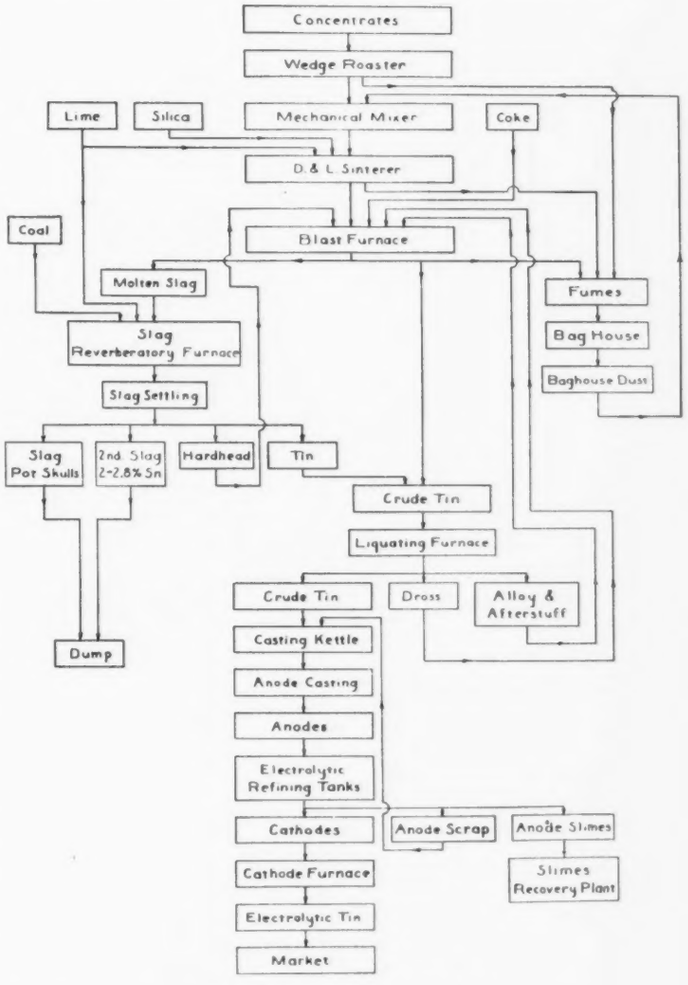


Fig. 3—American practice

English smelters can satisfy American requirements at a lower cost. English smelters offer to treat tin concentrates for £10 per long ton or even less.

The cost of production in the Bolivian fields per ton

of concentrate of 60 per cent to 70 per cent grade is given at £50 to £70[3]. Average ore milled is about 6 per cent tin, although lower-grade ores are treated when tin rises in price. The Sixteenth Annual Report of the Director of the U. S. Geological Survey states that the costs of smelting are in the following proportions: Fuel, 41 per cent; labor, 43; fluxes, 1; and general expense, 15 per cent. To the mines production cost must always be added the export duty and excess profits taxes of the governments in whose territory the ore originates. The price of tin is more or less regulated by the fact that when tin drops to £780 per long ton of metal, many of the smaller mines close, as they cannot afford to operate at this low price. Supply is thus curtailed and the price again rises.

Carbon Reduction

A review of the smelting of tin as above presented warrants the conclusion that present practice is not as simple as might be expected from the mere chemistry of eliminating oxygen from an oxide of a common metal. It is not always appreciated that nearly all of the difficulties in present-day tin-smelting operations are due to the rebellious nature of highly heated tin metal. Furthermore, the actual reduction mechanism is not as direct as the generally assumed equation $SnO_2 + 2C = Sn + 2CO$ would lead one to believe. Though tin was a metal well known to the ancients we are woefully ignorant of its metallurgy. The old Chinese reduction process, employing solid carbon, has been known and employed in various forms for thousands of years. Save for mechanical improvements, the present commercial method of winning tin from its ores is the same as it was three or four thousand years ago. The solid reducing agents used in various parts of the world are wood, charcoal, coke, peat, animal refuse, and various forms of coal.

Leplay and Laurent in 1837 (*Ann. Chim. Phys.* (2) 65, p. 404 on) ingeniously showed that solid carbon reduction is gaseous in its mechanism and that physical contact of reducing agent and reducible oxide was not essential. They placed a piece of solid carbon in a platinum boat in a furnace tube sealed at one end; in another boat alongside of the first they placed metallic oxides. Stannic oxide was used in some of the experiments. The tube was heated in a furnace, the open end in contact with the air. The solid carbon oxidized to carbon monoxide and dioxide and the metallic oxides were reduced to metal without contact with the solid reducing agent.

Our experimental work on stannic oxide and finely ground tin concentrates has confirmed these results. The stannic oxide was calcined at 850 deg. for one hour in the presence of air. The tin concentrates were roasted at 850 to 1,000 deg. C. for four hours. Graphite, ball-mill ground, was calcined at 850 deg. for one-half hour and at 1,000 deg. for two hours in closed crucibles in the absence of air. Determinations were also made in which calcined fuel coke and calcined petroleum coke were used. Their preparation is described later.

In the first determination, stannic oxide was spread over a layer of ground white "RR" alundum, in a 3-in. white "RR" alundum combustion boat. This boat was placed alongside a similar one filled with ground graphite. Both boats were placed in the center of a vitreosil tube 24 in. long, of 1 in. diameter, with a constriction at one end drawn down to $\frac{1}{8}$ in. internal diameter. The tube was heated in an electric furnace the temperature of which was controlled by external resistance. Temperatures were taken at the center of the tube by a calibrated base-metal thermo-electric pyrometer. Air, filtered through glass wool and absorbent cotton, freed of carbon dioxide by passage through columns of moist and dry soda lime in series, and dried by passage through concentrated sulphuric acid, was drawn through the heated tube at the rate of about one liter per hour. Separate determinations were made at 600, 700, 800, and 900 deg. C. each, over an eight-hour period. No reduction was evident at 600 and 700 deg.; reduction at 800 deg. was very slight; but it was easily seen at 900 deg., with the production of small tin globules on the surface of unreduced stannic oxide. Substitution of tin concentrates for the stannic oxide gave similar results. Further runs were made with stannic oxide and fuel coke; concentrates and fuel coke; stannic oxide and petroleum coke; and concentrates and petroleum coke. Practically all of the results were the same as those given above for stannic oxide and graphite, with the exception that petroleum coke seemed to give greater reduction at 800 deg. than did graphite or fuel coke. The results are given in Table I.

Table I—Carbon Reduction Tests

Boat 1	Boat 2	Temp. C	Degree of Reduction Observed After Eight Hours
1 g. SnO_2	5 g. graphite	600°	Not evident
1 g. SnO_2	5 g. graphite	700°	Not evident
1 g. SnO_2	5 g. graphite	800°	Slight
1 g. SnO_2	5 g. graphite	900°	Evident
1 g. concentrates	5 g. graphite	600°	Not evident
1 g. concentrates	5 g. graphite	700°	Not evident
1 g. concentrates	5 g. graphite	800°	Slight
1 g. concentrates	5 g. graphite	900°	Evident
1 g. SnO_2	5 g. coke	600°	Not evident
1 g. SnO_2	5 g. coke	700°	Not evident
1 g. SnO_2	5 g. coke	800°	Slight
1 g. SnO_2	5 g. coke	900°	Evident
1 g. concentrates	5 g. coke	600°	Not evident
1 g. concentrates	5 g. coke	700°	Not evident
1 g. concentrates	5 g. coke	800°	Evident
1 g. concentrates	5 g. coke	900°	Evident
1 g. SnO_2	5 g. pet. coke	600°	Not evident
1 g. SnO_2	5 g. pet. coke	700°	Not evident
1 g. SnO_2	5 g. pet. coke	800°	Evident
1 g. SnO_2	5 g. pet. coke	900°	Evident
1 g. concentrates	5 g. pet. coke	600°	Not evident
1 g. concentrates	5 g. pet. coke	700°	Not evident
1 g. concentrates	5 g. pet. coke	800°	Evident
1 g. concentrates	5 g. pet. coke	900°	Evident

In the tests with stannic oxide, reduction was evident by color change of the white stannic oxide to gray or black, with or without the appearance of tin metal globules, some of which might be of such size as to be seen only under the microscope. In the tests with tin concentrates, the tin globules formed more readily. Here, reduction was determined by testing the charges, after the run was over, by qualitative chemical methods. At the end of the eight-hour period, the furnace charges were cooled in nitrogen (freed of moisture, oxygen, and carbon dioxide) to room temperature before being examined.

Doeltz and Graumann report (*Metallurgie*, 4, p. 290, 1907) that carbon reduction of stannic oxide was not evident after one hour at 800 deg. C., but did show signs of taking place at 830 to 900 deg. It is interesting to observe at this juncture that carbon slowly oxidizes at 500 deg.; the oxidation of amorphous carbon is marked at 650 deg., and the speed of oxidation increases upon further rise of temperature. Commercial blast and shaft furnaces used for tin smelting operate over a range of from about 1,000 to 1,400 deg. C.

Charpy and Bonnerot (*Compt. Rend.*, 15; p. 644) attempted to determine whether reduction of iron oxide (Fe_2O_3) by carbon may be brought about by direct action between the solids or through mediation of the gas phase only. They studied the rates of reduction under a

[3]W. G. Jones: "Tin Fields of the World."

series of low pressures. Ferric oxide and graphite, previously purified, heated to 1,000 deg. in vacuum, mixed and strongly compressed, were heated in an electric furnace in a porcelain tube. The pressures were maintained and measured by a mercury pump and MacLeod gage. At 950 deg. C., under pressures of 0.01, 0.1, 1, 2, 4, and 8 mm. of mercury, the following rates of evolution of gas were found: 0.10, 0.14, 0.31, 0.56, 0.80, 1.07 c.c. per hour. The rate thus rapidly decreases with decrease of pressure, and the conclusion is drawn that, at least up to 950 deg., solid carbon does not reduce ferric oxide. If solid carbon does not reduce ferric oxide (when the carbon cannot oxidize owing to the presence of oxygen in the surrounding atmosphere) up to 950 deg., it will not reduce stannic oxide, which it will be shown later is harder to reduce than is ferric oxide.

Our experimental work has confirmed this finding. Finely ground graphite was calcined at 850 deg. for one-half hour and at 1,000 deg. for two hours. Stannic oxide was calcined at 850 deg. for one hour. These were intimately mixed and compressed in a small hand-press to a more or less compact mass. Ten-gram charges were placed in alundum boats in a tube furnace in a nitrogen atmosphere and subjected to temperatures of 600, 700, 750, 800, and 850 deg. for four-hour periods. The charges were cooled to room temperature before being removed from the furnace and its nitrogen atmosphere. The nitrogen had been purified of oxygen by passage over copper gauze heated to 200 deg. in an electric tube furnace, and freed of carbon dioxide and moisture by passage through several towers of soda lime and phosphorus pentoxide in series. After cooling, the charges were treated with concentrated hydrochloric acid for one-half hour and filtered. Then the filtrates were reduced by zinc metal and tested for tin by separate tests with mercuric chloride and ammonium molybdate. The mercuric chloride test was negative in each case. The ammonium molybdate test gave a very faint blue coloration to the solution, but it was not positive. Precipitates from the concentrated hydrochloric acid treatment were leached with dilute hydrochloric acid for one hour and the filtrates tested for tin as above. The mercuric chloride test, as above, was negative; the ammonium molybdate test gave a faint blue coloration which was not positive, even though the ammonium molybdate test is exceedingly sensitive to traces of stannous tin.

These experiments were repeated with finely ground (ball-mill), acid-washed fuel coke and finely ground petroleum coke treated with concentrated sulphuric acid. These carbonaceous materials were calcined at about 950 deg. for twenty-four hours in closed porcelain crucibles in electric furnaces. These materials were intimately mixed with calcined stannic oxide and treated as were the materials used in the experiments previously described. In no case was the mercuric chloride test positive in 100 c.c. of filtrate from the treatment of the charges with concentrated hydrochloric acid. In all instances except one, the ammonium molybdate test was exceedingly faint and not positive; a faint blue color could be seen only by comparison with pure water in a clean glass beaker. The stannic oxide plus calcined petroleum coke charge heated to 850 deg. for four hours gave a slight blue color with ammonium molybdate that was a shade darker than the other tests; even this, however, could not be called positive.

The smelting of tin from its ores, being really merely the reduction of stannic oxide ore, is, on first consideration, a simple process, but examination of commercial practice shows it to be far from simple. It is complicated by the many impurities to be removed, by the fluidity of tin metal at high temperatures, its ready alloying with other metals, and its amphoteric chemical character, which causes slag losses and necessitates slag retreatments. American tin practice dealt, when it was in operation, with the foulest ores and produced a tin metal superior in grade to any previously produced by foreign smelters.

Carbonaceous fuels in air atmospheres, out of contact with stannic oxide or tin concentrates, have been shown to have the power of reducing tin oxides by their own oxidation and passage to the gaseous phase. Carbonaceous fuels intimately mixed with stannic oxide, in nitrogen atmospheres, in the absence of oxygen have been shown to be without reducing properties, within the limits of the experimental range. The conclusion is therefore drawn that solid carbon fuel reduction of reducible metallic oxides is gaseous in its mechanism. Carbon reduction requires higher temperatures than gaseous reduction, as the carbon must first be gasified at a rapid rate. This rate becomes marked above 1,000 deg. C. Commercial tin smelters operate from 1,100 to 1,450 deg. C.

Metal Mines Are Largest Consumers of High Explosives

It will be noted from the table of explosives consumption that the metal-mining industry, as is to be expected, is far the largest consumer of high explosives, the quantity used during the last seven months amounting to 30.9 per cent of the total quantity used for all purposes. Coal mines used 11.5 per cent; quarries and non-metallic mines 28.4 per cent; railway and other construction work 15.9 per cent, and miscellaneous purposes accounted for 13.3 per cent. These figures were compiled by the U. S. Bureau of Mines.

Consumption of Explosives
January to July, 1927, Inclusive

Quantity used for	Black Blasting Powder, Kegs	High Explosives Other Than Permissible, Pounds	Permissible Explosives, Pounds
Coal mining	2,383,705	19,230,051	35,013,106
Metal mining	54,673	51,694,847	47,125
Quarrying and non-metallic mineral mining	140,341	47,599,928	301,070
Railway and other construction work	144,836	26,693,763	145,186
All other purposes	107,004	22,182,997	1,032,902
Total first seven months, 1927	2,830,559	167,401,586	36,539,389

Steel Containing Copper Resists Corrosion

According to M. Grison and E. Lepage (*Rev. Met.*, 1927, 24, 331-336), the addition of 0.5 to 0.7 per cent Cu to mild steel made by the basic or acid open-hearth process increases greatly its resistance to corrosion. Thus, in 20 per cent sulphuric acid three samples of ordinary mild steel lost 38 per cent in weight after six days, whereas similar steels containing 0.5-0.7 per cent Cu lost only 0.9 per cent. In sea water, after sixteen days, the losses were 2.3 per cent and 0.35 per cent, in running water 0.14 per cent and 0.065 per cent, and after two months in the atmosphere 0.10 per cent and 0.05 per cent, respectively. The addition of copper had practically no action on the mechanical properties of the metal.

Sinking the Randfontein Ventilation Shaft

(The following account of the sinking of the Randfontein Gold Mining Co.'s new shaft was given by W. G. C. Nixon in an address to the South African Institution of Engineers and is taken from the journal of that society.)

FIRST excavation for the Randfontein circular shaft was made on July 14, 1925, and rock was struck almost at the surface. When 18 ft. in depth was reached, the spoil having been removed by hand labor, a small temporary steel headgear was erected on girders raised 16 ft. from the ground, so as to permit of the collar of the shaft being built up to its full height of 15 ft. without obstruction. This temporary structure is shown in Fig. 1. While the temporary equipment was being erected, the sinking complement was employed on excavations for the foundations of the permanent sinking hoist and platform hoist. Sinking was then resumed with the temporary gear, the rock being hoisted in a 26-cu.ft. bucket by means of a suitable electric winch, which was subsequently used for hoisting the concrete skips. The shaft was taken down in this way to 47 ft., and concrete lining was started from the bottom. It was also opened out for the mat carrying the collar and main leg foundations of the permanent sinking headgear, so that all concrete work came up to surface together.

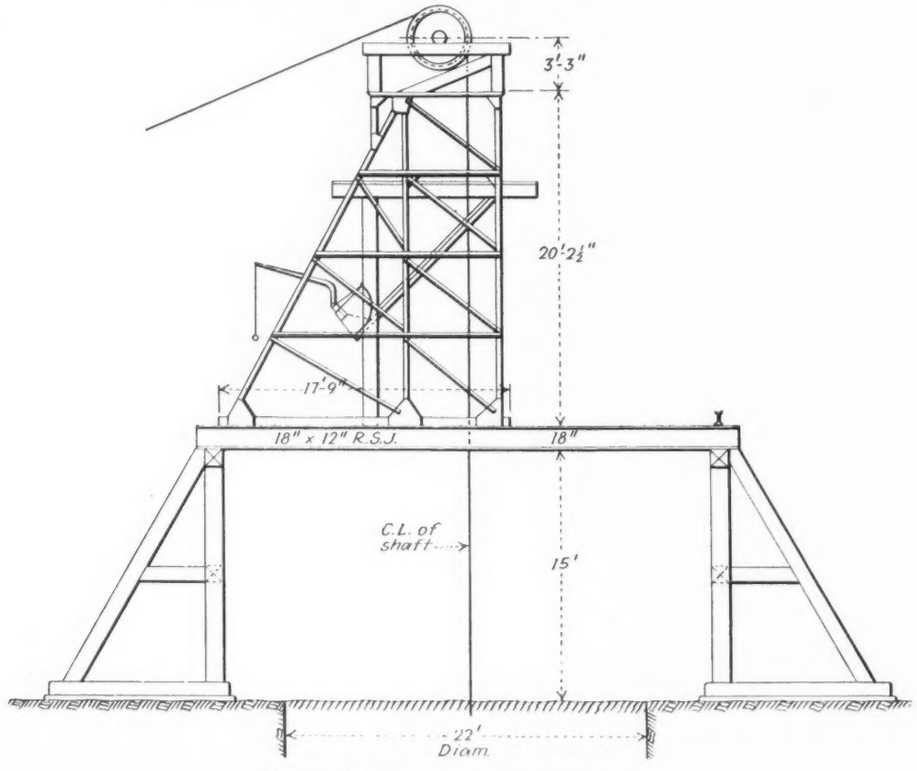


Fig. 1—The temporary steel headgear

The concrete lining was put in in mass, and the identical forms which had been used at Government Areas were transferred to Randfontein and were employed for lining the whole depth of the Randfontein shaft. They are still in sufficiently good condition for use in another shaft of the same size. The forms could be made stiffer, but the weight would thereby be increased, an obvious disadvantage when handling them in the shaft. The existing construction is $\frac{1}{8}$-in. plate stiffened with 3 in. x 2 in. x $\frac{1}{4}$ in. angles.

Nine forms go to a ring in the shaft, and they are fixed metal to metal except at one joint, where two $\frac{7}{8}$-in. wood strips are inserted. When the forms are to be removed after the concrete is set, these strips are first cut out, enabling the other joints to be broken easily. The vertical joints are each secured with two $\frac{5}{8}$-in. bolts and nuts and two taper pins, but the horizontal joints between rings have to be bolted throughout, because the ramming of the concrete tends to lift the upper ring. The concrete, having been brought up to surface level, was then continued to form the shaft collar 15 ft. above the ground. Forms were used for the inside shuttering, and the outside was built in good-quality brick, five courses of stretchers and one course of headers alternately, the concrete being placed between the brickwork

and the forms as the brickwork rose. During this period the foundations of the sinking and platform hoists were also put in, and the erection of these hoists and the permanent sinking headgear was then undertaken.

The sinking engine used for this shaft is a 450-hp. "Siemens-Robey" Ward-Leonard hoist, which was already on the property. This was the first occasion on which an electric hoist was used for sinking a shaft from the surface in this group of mines, and the decision to employ it was determined largely by the fact that the Randfontein distribution system is entirely by underground cable, with its much-reduced liability to interruption compared with overhead transmission.

The ropes used are of Latch and Batchelor non-rotating type $1\frac{1}{8}$ in. diameter, the construction being eight strands of six wires 0.091 in. diameter, over six strands of seven wires 0.081 in. diameter, over a triangular wire 0.0069 sq.in. area, over a core of seven wires 0.068 in. diameter. The breaking load of these ropes was 58 tons. It may be mentioned in passing that these ropes proved to be extremely dead.

The platform hoist was driven by compressed air in order to avoid the installation of a boiler plant. The four platform ropes were 1 in. in diameter, ordinary lay, having a breaking load of 45 tons each.

A permanent headgear was erected over the temporary one, and sinking and concreting were continued on night shift, the headgear erection proceeding during the day. By this means, footage was being gained daily without interfering with the construction party, and actually about 300 ft. of shaft was sunk and most of it was concreted by the time the permanent gear was ready for work. This method of construction by day and sinking by night had been adopted with success on shafts sunk on other properties, and 1,100 ft. was actually gained in this way in one of the earlier Randfontein shafts.

The concrete was loaded from a bin into special buckets constructed so as to be self-dumping on to the sinking platform. Each bucket has a hinged door in the bottom, attached to a central rod which passes loosely through the guide bars lying across the top of the bucket and forms the drawbar. The bucket is placed on a special trolley, and a pin is inserted through the drawbar above the guide bars, so as to keep the door closed while filling concrete. The trolley carrying the bucket is then run to the mouth of the concrete bin and is filled with concrete. It is then run back over the shaft doors, and the winding rope is shackled to the drawbar. The bucket is then raised to clear the doors, the trolley is removed, and the bucket is lowered to just above the sinking platform, the holes in which have previously been covered. Slings fastened to the crosshead guides are then secured to the rings on the edge of the bucket, and the pin through the drawbar is withdrawn; the winding rope is lowered, and as soon as the weight of the bucket is taken on the slings, the door opens and the concrete is discharged on to the sinking platform. The concrete is then shoveled into position and rammed by hand.

The collar of the shaft was equipped with air-operated doors, each pair of doors being opened and closed by its own air engine. The tip doors in the headgear were operated by counterbalanced hand levers.

The method of working the double bucket arrangement, which has been used with success at both Government Areas and Randfontein, was as follows: Three buckets are used, so that during the mucking period one is always in the shaft bottom being filled. When the full bucket reaches its highest point in the headgear before attachment of the tipping sling, the empty bucket has reached the shaft bottom, and the rope is detached from it, enough slack being allowed for this purpose in clutching-in the engine. When the top bucket has been tipped and is again raised for detaching the tipping sling, the rope in the shaft bottom is attached to the third bucket, which is already full and waiting to be raised. Assuming

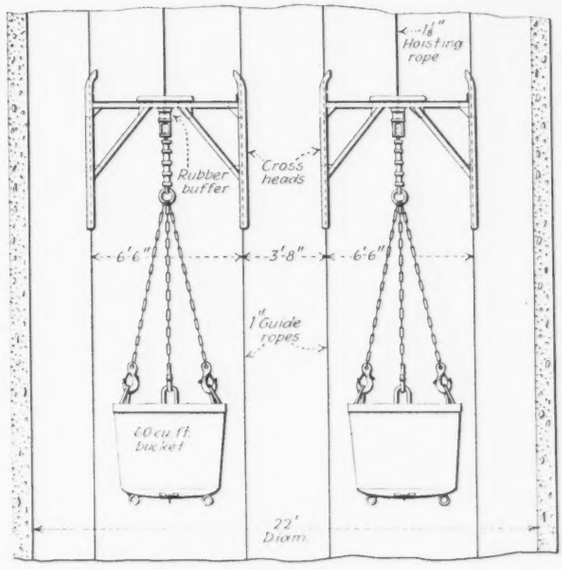


Fig. 2—Sinking buckets and crossheads

a winding speed of 1,500 ft. per minute, with this system in operation the hoisting beats the mucking down to about 2,500 ft., after which even with the three buckets the mucking beats the hoisting. With faster winding, of course, a greater depth could be reached before this would occur. Experience with double bucket winding at Randfontein proves once more that fears that buckets will collide in the shaft are groundless. The rope guides, which are the same ropes from which the sinking platform is hung, may oscillate considerably at a distance above or below the bucket, but on the approach of the crosshead the amplitude of oscillation diminishes, until the guides become rigid and motionless as the bucket passes. This effect is probably increased by the application of varying tensions to the four guide ropes, with resulting variation in period of oscillation. For this purpose the guide ropes are attached to the sinking platform by volute springs controlled by turnbuckles, enabling the weight of the platform to be unequally divided on the four ropes. The crossheads were provided with curved horns, so as to strike a glancing blow in case of collision, but this appears to be quite unnecessary. Crossheads and sinking buckets are shown in Fig. 2. The platform was kept as nearly as possible 50 ft. from the shaft bottom.

Ventilation of the shaft bottom was carried out by means of a "Sirocco" pressure fan delivering 15,000 cu.ft. per minute with open discharge, driven by a 30-hp. motor, and blowing fresh air down a galvanized-iron pipe $22\frac{1}{2}$ in. in diameter made in lengths of about 17 ft.

All pipes were extended as the platform was lowered, the air and water pipes being kept above platform level to avoid damage from blasting, and the bottom being served by several lengths of 100-ft. hose.

The shaft was cut 23 ft. 6 in. in diameter throughout, the internal diameter being 22 ft., leaving a 9-in. thick space for the concrete. Concrete lining was carried out

in sections, the greatest height of one section being 536 ft. In the system described, a start is made by drilling a ring of holes horizontally round the shaft, into which are wedged old jumpers. A timber bottom is laid on the jumpers, accurately leveled and centered, curved to the

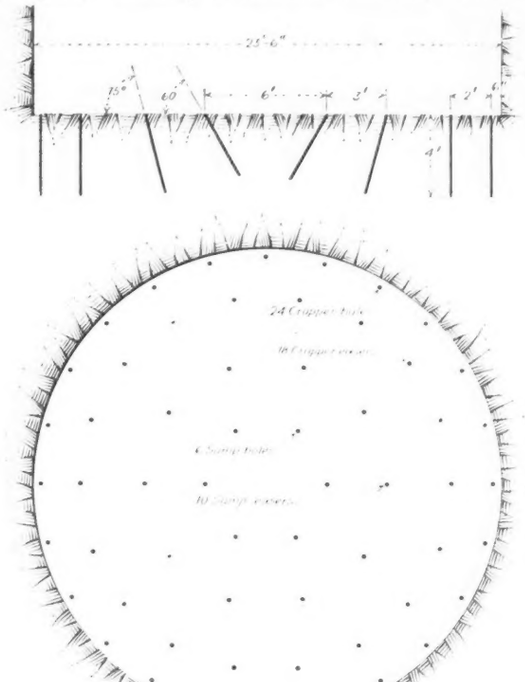


Fig. 3—An average sinking round

internal circumference of the shaft on the inside, and scribed to the wall on the outside. The first ring of forms is then erected on the jumper ends, touching the edge of the timber curb, leveled, and filled with concrete, the latter having been dumped on the platform as previously described. Each ring of forms is 4 ft. high, and as soon as the concrete reaches the top of one ring, the next is bolted on, the platform being raised to correspond. Ventilation, air, and water piping have, of course, to be removed as concrete is put in, to be replaced later. The desired length of concrete work being complete, the forms are removed and sent to surface. When all forms are stripped off, the pipes are replaced and sinking is resumed.

All of the work described was carried out by the usual sinking shifts, in charge of the stageman. For 200 ft. of shaft, the removal of forms and replacement of pipes occupied about sixty hours. In completing a section of lining, the concreting itself was stopped 3 ft. below the bottom of the section above, the starting point of the section having been carefully determined with this in view, and the intervening space is then made good with brickwork built and grouted in cement, in the form of a ring, for breaking the pressure of the machine water.

All the surface equipment previously described having been installed, sinking with three shifts was started on Feb. 2, 1926. The routine in such a shaft is as follows: On the night shift the blast would have occurred at 6.55 a.m. At 7 o'clock the sinker and his helper and the stageman go down, the stageman gets out at the platform, and the others proceed to the bottom, where they water and bar down loose rock. The native shift of about forty "boys" is then lowered, and at about 7:15 a.m. mucking begins, continuing till about 1:30 p.m. as a rule, depending on the depth drilled in the previous shift. At about 12 noon, however, the periphery of the shaft begins to get clear, and machines are started on the cropper holes, while mucking is completed. As the shaft clears more machines are put on, and finally it is possible to complete the sump holes. Drilling is usually complete about 2 p.m., when drills and hose are raised to the surface, and the native shift is also sent up. Charging-up then proceeds, and finally at about 2:50 p.m. the sinker and his helper light up, and the blast occurs at 2:55 p.m.

It will be noticed that the operation which chiefly governs this routine is mucking, and the bottom of the shaft is therefore kept as nearly level as possible to facilitate handling the broken rock. It is useless to break more rock than can be mucked in time to allow the next round to be drilled and blasted during the following shift, and so the depth of hole is fixed by the master sinker to suit the particular circumstances. These include consideration of quality of ground, efficiency of mucking and drilling, and depth from surface. Each foot of advance in a 23-ft. 6-in. shaft means mucking from thirteen to fifteen three-ton buckets, and the best mucking at Randfontein corresponded to about 4 ft. sunk per shift, or, say, a 180-ton break.

It is by consideration of factors such as those mentioned that the value of the double bucket at depths of more than 1,000 ft. becomes apparent, for it is easy to see that mucking will lag if there is not always a bucket in the bottom to be filled, and thus the efficiency of the whole operation will suffer. This is borne out by the facts that in this shaft at depths between 1,000 ft. and 2,500 ft. the average footage per sinking shift was 4.1, whereas from 2,500 ft. to 3,000 ft., when the mucking was beginning to beat the bucket again, the average fell to 3.2 ft.

The arrangement of the holes drilled during each shift may be of interest, and is shown in Fig. 3. Particulars given are approximate only, both as to number and direction of holes and their position, each round being set out to suit the conditions prevailing in the shaft at the time.

The record of 386 ft. sunk in a thirty-one-day month was accomplished from a depth of 986 ft. to a depth of 1,372 ft.; or just when the double-bucket system would be expected to begin to show its great advantages.

It is not suggested that the sinking of this shaft presented any acute difficulty. No water was cut, and for the most part the ground broke well, considering the steepness of the dip. It is, however, considered to be something of an achievement to complete such a shaft well within two years from the first excavation, remembering that a high angle of dip always tends to retard sinking.

The cost records in the sinking of the shaft to date have been as follows:

	Per Foot		
	£	s	d.
Sinking 3,421 ft.	14	16	0
Concrete lining 3,071 ft.	7	13	5
Hoisting	3	1	7
Shaft equipment	2	1	2
Surface equipment	4	19	2
	32	11	4

The item "Shaft Equipment" includes the shaft collar, ventilation and other piping, tubing, buckets, crossheads, ropes, sinking platform, and all such complementary appurtenances.

Theory and Practice in Selecting Grinding Media

By HARLOWE HARDINGE
Vice President, The Hardinge Company, New York

MUCH HAS BEEN DONE during the last few years to find out more about the value of various classes of grinding media. Many operators advocate unusual shapes and arrangements of grinding bodies, based usually upon theoretical considerations, although it is true that exhaustive tests have tended to indicate that special shapes and arrangements of media are preferable under certain conditions.

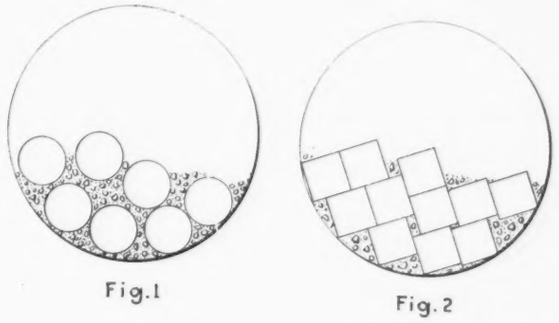
I have read with interest several articles on this subject. I have also carried out research in the laboratory and in the field. The result of this has left me far from satisfied that I have a reasonable grasp on the subject. Factors have been brought to light that I do not think have been considered in their possible application to commercial benefit. It is highly important to develop the theoretical aspect as far as possible; but if theory does not improve practice, it has no value. It appears to me that some of those who have studied this problem have failed to remember that theoretical considerations must, in the end, point to the commercial aspect of the matter—to the encouragement of operation at the lowest over-all expense.

I outline below most of the factors that effect both the theoretical and practical side of this question. It is hoped they will help to throw a little more light on a problem that is of no small importance to the millman.

WEIGHT PER UNIT OF VOLUME

From the viewpoint of space required it stands to reason that the heavier the grinding media the smaller they may be without appreciable loss of crushing force. An example of this is the ratio of weight between steel balls and flint pebbles. A 5-in. steel ball weighs approximately 20 lb., whereas a 5-in. flint pebble weighs approximately 8 lb. This means that, for the same volume, a 5-in. steel ball has two and a half times the weight of the same size of pebble. For grinding coarse feed in the same mill, the 5-in. steel ball is able to exert a much greater crushing force than the 5-in. pebble; but it also follows that to lift this 5-in. steel ball takes a great deal more power than is required to lift the 5-in. pebble.

For a given volume, and considering only the condition cited above, it would appear that smaller balls, with more contacts per total weight of mill load, would give better results than pebbles. This is true in many cases but not in all, as will be pointed out later. For a given mill, cubes or square rods give the greatest total weight per charge. Round rods come next, and round balls last (see Fig. 1 and Fig. 2). Other odd shapes, such as hexagonal and concave, will arrange themselves in between. It is well to note that round balls appear to be the least efficient in this regard; yet balls constitute the media most used in practice. A mill loaded half full of 5-in. balls has a considerable number of voids, which can be reduced by the addition of other balls small enough to go in between them; and the voids between these small balls can be again diminished by using still smaller balls, and so on to the condition where, theoretically, the mill volume could be all but filled with round balls. In practice a modification of this condition exists.



Figs. 1 and 2—For a given mill, cubes or square rods give the greatest total weight per charge. Round rods come next and round balls last

The surface area of a ball corresponds to the surface area of a flint pebble of the same size, if the pebble is perfectly round; but the weight of the ball is much greater with different sizes of the grinding media, than that of the pebble. It follows that the surface increases per unit of volume or weight as the size decreases. For instance, a 5-in. steel ball has a surface of 78.54 sq.in., whereas a $\frac{7}{8}$-in. steel ball has a surface of 2.4 sq.in. A ton of 5-in. balls will have a total surface of 7,854 sq.in. A ton of $\frac{7}{8}$-in. balls will have a total surface of 48,600 sq.in., or 6.2 times that of the same total weight of 5-in. balls.

A thin, flat plate gives the most surface per unit of volume or weight; cubes next; round rods next, and balls last if slight spaces are allowed between each piece. Here again it will be noted that balls have less surface exposed per unit of weight than any other shape of grinding media considered. This would indicate that balls are not so good grinding media as odd shapes if surface were the prime consideration. Findings in actual practice indicate that such is not the case.

If a grinding body falls upon a more or less plastic mass, the effective force exerted depends upon the area exposed to that force. A sharp edge exerts the most concentrated force; round next, and flat last. In other words, it is simply a case of pounds exerted per square inch of surface exposed to the crushing force (see

Fig. 3). On the other hand, should the grinding body fall upon a substantially inflexible mass, such as a piece of hard ore, the force exerted by any of the different

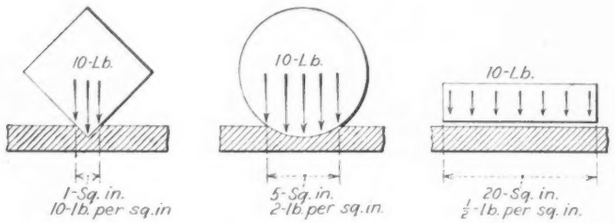


Fig. 3—If a grinding body falls upon a more or less plastic mass, the effective force exerted depends upon the area exposed to that force. A sharp edge exerts the most concentrated force, round next, and flat least

shapes of grinding media would be almost the same. The area of contact would be the same for all intents and purposes, because it is limited by the surface in contact with the particle of ore (see Fig. 4). This is an important consideration and one that has not been given the attention it should receive from the theoretical standpoint. It is closely associated with the force exerted per unit of weight.

The greatest weight per total surface is a sphere or ball. This, of course, when considering the force against a more or less plastic mass. But if an inflexible mass is considered, it makes no difference theoretically what the shape of medium is. The force or pressure per square inch would be the same, as it is limited by the point of contact against this mass. Fig. 4 illustrates this point also.

The force exerted depends upon the total mass of the media under consideration, the height of free fall, and the area or surface exposed to the blow. From the standpoint of foot-pounds of energy exerted, a ball weighing 5 lb. dropping 1 ft. should have the same crushing force as another ball weighing 1 lb. dropping 5 ft.; but the ball weighing 5 lb. will cover a greater area than the one weighing 1 lb. (see Fig. 6); and, therefore, the energy may be dissipated over the surface to an extent which would prevent actual crushing, if the mass upon which the force is struck is plastic, such as a bed of sand. However, if the mass is inflexible, the force exerted and the crushing effect would be the same.

Angle of Nip

With crushers and rolls, the so-called angle of nip is an important consideration and governs the construction and operating features. The so-called angle of nip in a ball or pebble mill has been given but little thought, although here, too, it is as important as in the case of crushers or rolls. The angle of nip is considered in this case as that angle at which the components of the forces, including friction, which act to hold the particles between the crushing surfaces, are just balanced by the components of the forces which tend to snap the particles outward.

Two flat disks or bars approximately parallel have maximum efficiency so far as the angle of nip is concerned; or, in other words, the angle would be zero. But if these bodies did not come together in an exact parallel position, the angle of nip would then be equal to the angle at which one edge struck the other, and a great deal of the effective crushing surface would be lost (see Fig. 5). On the other hand, two round surfaces coming together always have the same angle of nip, and although this angle is considerably greater (and hence the crushing surface exposed is less than two plates meeting each other) the probability of obtaining effective crushing is much greater.

The larger the ball the greater will be the crushing surface; but, also, the larger the balls in a given mill, the fewer will be the total number of balls; hence, there will be fewer points of contact or total surface in square inches. Fig. 6 shows the difference in crushing area of two sizes of balls or rods, assuming the angle of nip to be 31 deg. The question arises as to the ideal size and composition of balls, rods, or other shapes that should be used to obtain best results.

Forgetting for the moment the wearing qualities of

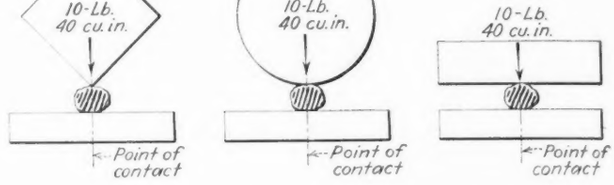


Fig. 4—If a grinding body falls upon a substantially inflexible mass, such as a piece of hard ore, the force exerted by any of the different shapes of grinding media would be almost the same. The area of contact would be the same to all intents and purposes

different shapes and compositions of grinding media, thought should be given to the character of the surface exposed.

The effective crushing area of a round rod or ball depends to an appreciable extent upon the friction as well as the size and weight. A rough surface has greater friction than a smooth surface. Particles to be ground would not slip out from between two flint pebbles as readily as between polished-steel balls. Cast iron has a rougher surface, even when worn comparatively smooth, than an alloy-steel ball. On the other hand, if the surface be too rough, particles may lodge in the crevices and cushion the blow, thus reducing the grinding efficiency.

From the economic standpoint, the composition of the grinding media is governed to a large extent by the ratio of rate of consumption to the cost of the media used. Other factors must also be considered, such as convenience and cost of handling. The advantages in using a local, inferior product costing less per ton of ore milled, based on the metal or pebble consumption alone, may be outweighed by the inconvenience in handling and contamination of the product.

In the case of a ball, pebble, or rod mill, grinding is done within the mass as well as on the surface where the balls, pebbles, or rods cascade down the slope. The faster the mill revolves (until, of course, centrifugal cling takes place) the freer will be the action of the media. It would be expected that the faster the mill goes the better will be the total grinding effect. This is not so in all instances by any means. It appears that the condition inside the mass of balls and material changes with the change in speed. Many tests made to determine the effect of speed on this mass indicate that a circulation takes place that has a great deal to do with the grinding effect. When the mill is operated too fast the grinding effect within the mass is diminished and the crushing effect

of the media on the surface is increased. The result of high speed in most instances is to obtain a higher capacity on relatively coarse grinding; but if fine grinding is desired, better results are secured at a lower speed.

In a mill where the grinding media consists of nothing but cubes or square rods, theoretically there would be but little room for material if the mill contained a full load of such cubes or square rods. Next would come round rods, and, lastly, balls, the odd shapes in between. Fig. 1 and Fig. 2 illustrate this condition.

If a mill contained a full load of balls, of the same size, the volume available for material would be approximately one-half of that occupied by the balls, because a sphere of the same diameter as the side of a cube occupies 0.52 of the volume of the cube. As a matter of fact, in an ordinary ball mill, the balls are of different sizes, and, therefore, the theoretical volume available for material is less than 50 per cent, as the small balls will tend to fill in the spaces left between the large balls. The material will spread the balls apart somewhat, and the ratio just mentioned could not exist unless the material is extremely light and of very thin consistence. It is

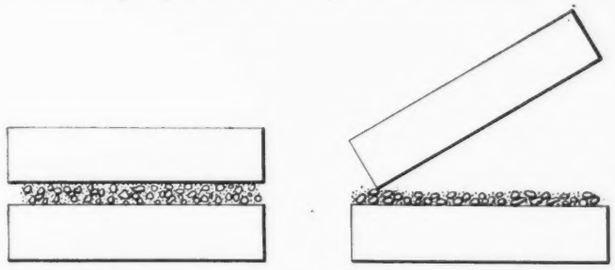


Fig. 5—If two flat disks or bars approximately parallel do not come together in an exactly parallel position, a great deal of effective crushing surface is lost

well to note that the ball in this case has the advantage over any other shape in that it has the greatest weight per unit of surface and still allows more material in the mill, upon which it can work without coming in contact with its neighbor, which would mean a loss in efficiency and, incidentally, an increase in wear.

If too much material is allowed to enter the mill, and it is of sufficient weight or size to spread the grinding media apart, the crushing effect will be greatly diminished, or may cease, inasmuch as the crushing force of even a larger ball or rod is not sufficient to break through the mass and do effective work. It also follows that if too little material enters the mill, or if it is very fine, the wasted energy will be appreciable, because the grinding media will be striking each other. The best condition is when the size and weight of grinding media are so proportioned that each is just sufficiently heavy to crush at a single blow the largest piece entering the mill. A larger weight is unnecessary and wastes energy. Too light a weight could not do the work.

The capacity of the mill and the fineness of the product secured are dependent on the physical characteristics of the ore. The principal variables to be taken into consideration are (1) friability of the ore; (2) screen analyses of feed; (3) whether the grinding is to be done wet or dry; (4) the shape of the particles, and (5) physical structure throughout the range of reduction. For instance, one ore may be uniform from 2 in. to 200 mesh, whereas another may crush readily down to 20 mesh but be difficult to crush thereafter.

Some operations call for granular grinding, in which a minimum of fines is desired, whereas others require a maximum of fines. If a minimum of fines is desired the method of obtaining this is to crush the material quickly with not too heavy a blow and then remove it without over-grinding. If a fine product is desired, the material should be crushed with a heavy blow or an infinite number of light blows.

I have conducted many tests on different classes of grinding media and have developed and tested out special shapes which were considered at one time to be of marked advantage over others. It has been found that these special shapes have special applications, but the field is limited at best, because they have proved superior in certain cases only and cost more to make.

The media tried have been balls, pebbles, round rods, flat disks, short cylinders, double cones, a mixture of balls, cubes, flat disks, and other odd shapes. I had the idea, as have others, that, for very fine grinding flat disks would give excellent results. This was investigated by grinding such materials as coal, limestone, and wood chips. Flat disks have the greatest surface exposed of all practical grinding media; by "practical" I mean those that lend themselves well to the operation within the mill and can be secured cheaply. It appeared that when grinding a soft material like coal flat disks would be by far the best media to use. Upon making an accurate test, in direct comparison with balls, it was evident that balls were the better of the two. This was a surprise until the problem was studied further. The chief obstacle is the lack of weight or crushing force per unit of surface exposed. In other words, a ball with its relatively small surface, but relatively great weight per exposed surface, apparently falls through the mass of partly broken material and does effective work, because the surface of contact is small and therefore the foot-pounds

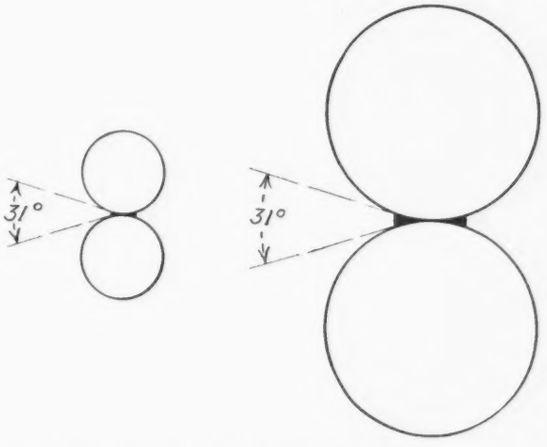


Fig. 6—This shows the difference in crushing area of two sizes of balls or rods, assuming the angle of nip to be 31 deg.

of energy exerted per square inch are large. Disks either hit on the ends, which produces little result (see Fig. 5), as the surface is very small; or they hit on the surface where the area of contact is too large for the pressure exerted to crush the coal lying between it, with a consequent loss of energy. Then, again, disks occupy a great deal more of the interior of the mill than will the equivalent full load of balls. It is true that a greater weight of disks in a given mill can be obtained, but without sufficient material upon which to work, the capacity per unit of power consumed is reduced.

When rods are used, another condition occurs in which a compromise must be made between the disks and the balls. The rod takes up more space in the mill than the ball, and its exposed surface per unit of weight is much less than that of the disk. Theoretically, the rod is efficient in grinding, as there is line contact; but, actually,

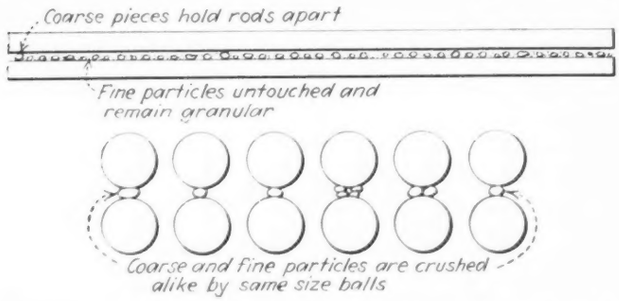

Coarse pieces hold rods apart
Fine particles untouched and remain granular
Coarse and fine particles are crushed alike by same size balls

Fig. 7—This would indicate that an excellent granulating effect is produced with rods, and that balls are the better pulverizers. But other factors may alter conditions

when fine grinding takes place, this line contact does not exist, as the rods do not line up accurately, and unless they line up perfectly very little more grinding will result than with the balls in the same location, weighing much less. If the rods are in perfect alignment and a coarse feed is being crushed but not totally crushed between them, any other particles lying on the rods, of smaller size than the particles under consideration, do not receive any crushing force; whereas in the case of balls, free to move and in greater number than rods of the same weight, this loss of energy does not occur. By this same reasoning, however, it is evident that an excellent granulating effect is produced with rods. When they come together, they do not mesh the particles to the same degree as do the balls with their freer action and greater over-all effective crushing force per unit of area. Fig. 7 shows two rods with the particles between and how the granulating effect is produced. It also shows balls occupying almost the same volume and free to grind the coarse and fine particles alike, which tends to produce a finer product.

From the above, the deduction follows that a rod mill is the best granulator and a ball mill the best pulverizer. Other factors may alter conditions. In several cases ball mills have proved equally as good as and sometimes superior to rod mills where a granular product is desired.

In regard to cubes and other special shapes, the surface is greater than with equivalent balls; and, unless these surfaces are almost parallel as they come together, part of the crushing force is lost, because the edges in coming together present but little surface available for crushing. This does not mean that cubes and special shapes are not efficient. With many ores and under certain conditions of operation they have proved satisfactory.

In considering the use of pebbles, the fact should be noted that the weight per unit of surface is small and therefore a larger mill must be used to secure the same crushing force. Strange as it may seem, the pebble mill for fine grinding is still as efficient as the ball mill; in fact, more efficient under certain conditions, although capacity limitations and popularity of the ball mill have prevented the pebble mill from retaining its position in the field in which it once reigned supreme.

In practice, ball and rod mills are usually charged with different sizes of balls and rods. Large balls and large rods do the crushing and the smaller sizes do the grinding. It is true that where the small balls or rods strike the large pieces they are unable to crush them; and, therefore, the energy is lost. On the other hand, surface per unit of weight of the smaller sizes is so much greater than of the large rods that they make up for this loss in being able to reduce the partly crushed ore more efficiently than if only one size of balls or rods were used in the mill. Another important consideration in regard to the size of the grinding media is the wear that occurs. Large balls have less surface per weight than small balls; and, therefore, it would appear that the consumption would be considerably less than that of the equivalent amount of small balls in the same mill. On the other hand, the force exerted is many times greater; and where conditions are not right and the mill is run under capacity the metal consumption is high, because the balls come in contact with each other with a great deal of force; and, therefore, metal particles are spalled off. The same is true of rods, flint pebbles, or any other grinding media.

Small balls usually show a greater metal consumption than do large balls in mills operating up to capacity, because of their infinitely greater surface contact and chance for wear. In examining operating reports of mills one is likely to lose sight of the fact that another reason for high ball consumption of a mill using small balls is due not so much to the increase in surface contact as to the character of ball used, and its composition. For primary grinding, where a coarse feed is being supplied to the mill, balls exceeding 3 in. are almost always used, in which case they must be made of steel or some special cast alloy sufficiently strong and hard to withstand the impact. In fine grinding, the mill is usually run at the lower speed, and the balls are smaller, thus decreasing the crushing force. Cast iron or an inferior grade of metal may be used, with different results.

The cheapest media are usually large lumps of the material itself. The shapes are irregular as a rule, the mill efficiency is low, and the wear is excessive; therefore, in the long run, it seldom pays to use this type of grinding medium. Flint pebbles or jasper cubes are next in cost. They are much lighter than metal shapes; hence, more mills are required to do the same work. When the rod mill first became popular, the price of rods was much less than that of steel balls, as scrap shafting and the like were to be had in abundance. Subsequent practice has demonstrated that rods of definite analysis should be used principally to obviate the possibility of twisting in the mill when worn. This increased the cost. With improved methods of making balls the marked advantage in cost per pound of rods has now disappeared, and as a result the field of grinding with rods has become limited. Since the recent discovery of processes for making small forged and cast-steel balls these have encroached on the field of the cast-iron ball.

Special shapes such as cubes, short cylinders, disks, and the like cost more as a rule than the equivalent ball or rod, because of their limited production and because they are more difficult to make; and this is another reason why special shapes have not been used more in practice.

In conclusion, all of the work done to discover something about the peculiarities of various grinding media has been carried out with the economic factors in mind. A start was made on a theoretical basis, but in the end it was necessary to make theory fit practice. Even after fifteen years of study, I feel that no single solution will meet all conditions. Too many have entered this field of research and have failed to take into consideration basic facts that may be rather obscure but are of considerable economic importance.

DISCUSSION

Investment in Mining or Real Estate?

THE EDITOR:

Sir—The views expressed by J. H. Farrell in the Sept. 24 issue indicate a condition that is typical of developed mines as well as prospects in this section.

It appears to be useless to prospect with the expectation of selling a discovery. The sale of a mine or a prospect hereabouts is a rarity these days. Apparently there is a concerted boycott against prospects in this part of the world by the well-known and successful mining organizations. This may be done to keep down production, or to discourage development and for the purpose of reserving the mineral wealth of this section for future use. Or it may be due to difficulty in financing properties, a condition perhaps brought about by wildcatting and crooked promotion, or to the operation of cycles in public interest.

Basic industries in California are fast reaching a plane where many of the best of the developed properties and Class "A" prospects are in line for exploitation, but there seems to be some weakness in our system of mining ownership and promotion. Thousands of young people begin early in life to invest their savings in real estate, knowing that profits, if ever made, will be deferred many years. At best they can hope for only a modest profit, based usually on the increased value of their holdings, brought about by growth of the community. If some plan were devised whereby mineral claims and resources could be stabilized and their future status as definitely established as is real estate, part, at least, of this savings fund would be directed toward acquisition and development of mineral and metal resources.

In this section today every public and quasi-public organization is outwardly against mining. Privately the bankers, manufacturers, merchants, and even the real-estate men dabble in mining, but not as intelligently as they should. They gamble, and the more remote the property the better and the less likely they are to be discovered. The more glamour and mystery that can be attached to the deal, the better. Go to them with a local resource, of undoubted value and greater merit, and they inform you that they never dabble in mining and invariably direct you to an engineer that you know represents one of the great mining organizations, but whom you know does not represent their money in the gambles conducted under cover.

Until there is intelligent backing of local resources by men recognized in the community as honest and efficient and successful, the average investor is ashamed to acknowledge an interest in mining. Such an attitude breeds an erroneous standard. The younger generation of investors, who might and are entitled to participate in these mineral resources, become confused and discouraged, and the older and more experienced investor is frightened out and exerts his influence to scare others.

Surely, an investment for future profit, in the mining industry, offers greater hope of profit than any other type of investment. Probably the law of average in mining will bring profit sooner than in real estate or manufacturing, for example.

In Los Angeles some real estate has been productive of profit; quick returns have been made on small investments. Probably this could be said, in a lesser degree, of any other metropolitan area. But in Los Angeles the paper profits in real estate have misled many an investor. A close observer of this situation for the last twenty-three years, with considerable participation in it at many stages and periods, convinces me that it is more disappointing than mining and offers less hope of reward. If an investor had bought a well-located property twenty-five years ago, and stayed with it down through the years, paying the assessments and expenses incident to a rapidly growing community, it is bound to show a splendid advance on his investment. But in the average case the increase has not been high; it has been substantial but not unusual. I do not decry real estate as an investment, but real estate to the exclusion of legitimate mining, as appears to be the scheme here, is unfair and unbusinesslike. Mining should at least stand on an equal footing.

But why should any resources in this great area go begging? A score or more of meritorious propositions lie dormant, within a day's ride of Los Angeles or San Francisco, with ideal conditions surrounding them, and they can be put on a profit basis with small outlay.

The only method that works here is to syndicate a particular property with a group of men who know nothing about mining. Such an organization is likely to be over-optimistic and under-financed. It does not appreciate the drawbacks and difficulties that waylay every mining enterprise or understand the cure; and at the first sign of trouble the investors abandon the organization, leaving the investment suspended and the property discredited. Such things have happened to the best of the experienced mining organizations; several notable ones can be recalled of recent date; but the experienced organization works itself out of the difficulty and wins success in spite of everything. However, I am fully convinced that the syndicate idea is good, but it should be backed by the best men of the community, men whose success inspires confidence and whose motives are in part public spirited. It must contemplate reasonable profit, but it must have the further incentive of developing a resource that will benefit the community. There is no valid reason why our Coast cities should not have many more profitable and long-lived enterprises pouring their wealth into the communities involved.

Until the lawyers, bankers, manufacturers, merchants, and agriculturalists accept mining as a legitimate industry and see that it gets its just proportion of working capital, the unscrupulous promoter will continue to fleece the unwary and discourage the class of investor needed by the mining industry.

E. D. FOSTER.

Los Angeles.

More References to Previous Literature Wanted

THE EDITOR:

Sir—Your "By the Way" paragraph concerning your typographical changes, which appeared in the Sept. 24 issue, prompts me to comment. The new type is, I understand, a stimulant to the editor and a means of kindling the reader's interest up to the level where he will say resignedly, "I wonder what we will have next—a new type, a rearrangement, a new editor—go on!" "Mein Liebchen, was willst du noch mehr!" said Heine.

Indeed, the first two changes have greatly improved the magazine, I must say (and so do my colleagues, by the way). Concerning our editor for the present future, I had better say nothing, feeling to be not competent to do that. In case you might find yourself again in a position to carry through improvements (of course, your frame of mind is always inclined that way), I would suggest making more references to the principal articles previously published, as far as they are of practical assistance and cover the same subject. Especially where many-sided polemics are involved, readers would be stimulated to refer back to their old copies and reject a better tailing out of them. This would more particularly apply to the man in the field, who usually peruses his copy once, more or less carefully, and then puts it aside on the shelf (if not worse), never to look at again unless to look at an occasional article probably written by himself.

To avoid the impression of a too dithyrambic nature, it is well not to mention further improvements now. After all, *E. & M. J.* is my best-favored paper.

Haarlem, Netherlands. T. DE VRIES.

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Manganese in Virginia

THE EDITOR:

Sir—Old records show that the Paddy's Run manganese mine, in Frederick County, Va., was operated in 1832, being the first manganese mine to be worked in Virginia as well as the first in the United States. In 1857 another mine was opened near Waynesboro, in Augusta County. In 1868 and 1869 a large quantity of manganese was mined near Warminster, Nelson County.

Virginia has more known deposits than any other state in the Union, and more high-grade ore has been produced. Nine out of ten properly directed explorations have resulted in locating good deposits of manganese.

Manganese ores occur in the three major geologic divisions of the state—namely, the coastal plain, Piedmont, and the mountain province.

On the coastal plain in Prince George County, near City Point, a large deposit has been worked and deposits in several parts of the country have been partly explored.

In the Piedmont region workable deposits are found in Albermarle, Amherst, Appomattox, Buckingham, Campbell, Nelson, Pittsylvania, and Spottsylvania counties. Some of the miners in this area have produced high-grade ore for many years. The Cabell mine produced 5,000 tons in 1869 and the Simpson 12,000 tons in 1882.

In the Mountain region the ore belt lies along the eastern side of the valley, extending through twelve counties. The most famous mine in the state and in the United States is in this region, being the Crimora mine, in Augusta County. It has produced more high-grade manganese ore than any other mine in the Union.

Geer, Va. MARSHALL HANEY.

By the Way

In the Effete East

FROM the New York *Herald Tribune* of recent date we cull the following.

Edison Will Set Off Blast
And Loosen 150 Tons of Rock

NEW VILLAGE, N. J., OCT. 2.—Thomas A. Edison is to throw the switch here tomorrow afternoon at 2 o'clock, to set off the biggest blast in local history at the Edison Portland Cement Company quarries.

Workingmen have been preparing for the blast for several weeks. One hundred and fifty tons of rock will be loosened at once; but engineers said that the charge has been deeply buried, so that the report will not be very loud. A reception is to be given to the aged inventor, after the ceremony, by officials of the company.

Assuming the data given to be correct (and the *Herald Tribune* is a reputable newspaper), it is suggested that if Mr. Edison wants to do something really big he go out West, where blasts are blasts. But we are inclined to put more confidence in the story in the *Times,* which says that the blast in question loosened 160,000 tons of rock, the *Herald Tribune* evidently missing about three ciphers. But even 160,000 tons is far from a record. The Chile Copper Co. is understood to have loosened nearly a million tons at one blast; and out in Corona, Calif., about three years ago, it was estimated that two million tons of rock was dislodged when the Blue Diamond Materials Co. shot off 182 tons of dynamite.

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The Teniente Orebody of the Braden Mine

IN AN ARTICLE published in a recent issue of this journal, the Teniente mine of the Braden Copper Co. was said to be of "a fairly regular elliptical shape, about what Lindgren terms an ancient crater." A reader stated that he felt sure that this was not in accord with Professor Lindgren's views on the subject, which, correspondence develops, are as follows: "I have called the Braden mine, not a crater, but a volcanic explosion vent. Of course, there is a distinction between these two things. Cripple Creek is, for instance, a volcanic explosion vent, and there are other similar deposits. The idea was that the mineralization occurred after the explosion vent had been filled in chiefly along the periphery of the pipe. You will find the matter referred to on page 696 of my book 'Mineral Deposits.'"

* * * *

Faith

THAT more than 375,000 persons are so anxious to obtain a Ford of the newer model that they have placed orders without knowing what the price is to be, what the new model will look like, or what it will do is perhaps the most romantic episode that the history of industry affords. As an evidence of faith the circumstance is without precedent or parallel example.

Whether Henry's new baby will go to the moon and back on a gallon of gas doesn't much matter. It may not. Miners, merchants, and men know, however, that back of the name lie intrinsic and even intangible values. Their faith in the new car is based on the firm foundation of confidence created by an honest product, by dependable performance, and by efficient servicing.

NEWS OF THE WEEK

Summary

A REPORT, originating in London, that British, Dutch and American tin interests are taking steps to peg tin at £300 a ton for a year is denied.

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Attorney General's department of Ontario, in dealing with fraudulent stock-promotion schemes and high-pressure selling methods, raids a number of brokerage houses and makes arrests.

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Diamond-cutting industry is to be established at Kimberley, South Africa, the Union government having entered into an agreement with an experienced firm to launch the enterprise.

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L. Heller & Son, of New York City, importers of precious stones, purchase concession on the Ural emerald mines from the Russian Soviet government.

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M. R. W. Mining Co. takes over Casson manganese mine, in the Batesville-Cushman field of Arkansas, and places pilot mill in operation on the property.

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Principal mining districts of Mexico are not affected by attempt at revolution, which started with mutiny of troops in Mexico City garrison.

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Placer prospecting increases in Bolivia and placer tin promises to become an important factor in the country's tin output.

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A gold-silver-lead strike is made in the Prospect Mountain section of the Eureka district of Nevada.

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Seat on the Standard Mining Exchange of Toronto bought two years ago for $4,300 sells for $40,000.

The Sullivan zinc plant at Kellogg; main building in background, steel work for tank house in foreground

Coeur d'Alene Zinc Properties Prepare for Production

Two Electrolytic Plants, Now Under Construction at Kellogg and Anaconda, in Operation Next Spring—Contracts Offered Mines—Golconda to Erect Mill

ALTHOUGH the low price of lead continues to be a matter of concern in the Coeur d'Alene district, Idaho, the depressing effects are in a measure offset by the brighter outlook for zinc in spite of the prevailing low price of that metal also. This is explained by the fact that the time is near when a local market will be available for Coeur d'Alene zinc through the completion of the electrolytic zinc plant under construction by the Sullivan Mining Co. (Bunker Hill & Sullivan and Hecla). It was originally announced that this plant would be capable of turning out 50 tons of metallic zinc per day, but, as a matter of fact, it will have a capacity considerably in excess of that figure. Its completion will be followed by construction of another unit of like capacity, making a total capacity of approximately 150 tons. It is now estimated that the unit under construction will be in operation by April 1, possibly earlier.

The Star mine, owned by the Sullivan company, is in condition to supply a large tonnage. The output of the Sidney mine is under contract. Concentrate from this mine is accumulating at the Sweeny custom mill and will assume large proportions by the time the zinc plant is ready to receive it. This custom mill is owned and operated by the Bunker Hill & Sullivan company, which recently took over 325,000 shares of treasury stock of the Douglas Mining Co. The transfer provided funds for further developing the mine, the deal also including a contract to purchase all Douglas ore for fifteen years. The ore will be treated at the custom mill, zinc being the chief product, which will go to the electrolytic plant, the lead being sent to the Bunker Hill smelter.

Highland-Surprise to Resume

It is understood that the Highland-Surprise mine is preparing to resume production, having been assured a contract for its zinc at the Sullivan plant by April 1. This mine has been inactive since last spring, when its contract with a Belgian zinc smelter expired. Other zinc properties on Pine Creek and elsewhere in the Coeur d'Alene district are preparing for production in anticipation of the completion of the Sullivan electrolytic plant, a situation that gives

a cheering outlook for zinc in the Coeur d'Alenes.

Another factor that has a bearing upon the zinc situation in the Coeur d'Alene district is the new electrolytic zinc plant being built by the Anaconda company at Anaconda, Mont., which will have a capacity of 150 tons of metallic zinc per day. This will also be in operation next spring, and it is reported that Anaconda is already offering contracts for Coeur d'Alene zinc effective upon the completion of the new plant.

Golconda to Build 100-Ton Mill

The Golconda Mines Co., operating in the Coeur d'Alene district near Wallace, Idaho, is planning the construction of a flotation mill of 100 tons' capacity soon after the first of the year. A recent letter to the stockholders from N. C. Sheridan, vice-president of the company, described development plans now being carried out as consisting of a raise and shaft from the main tunnel level designed to block out ore, and added: "This work should be completed not later than the first of the year, by which time your management feels confident that enough ore will have been blocked out to warrant immediate construction of a modern flotation concentrator." The Golconda was originally called the Hector. Under that name a crosscut tunnel a mile in length was driven by assessments and the enterprise was finally abandoned as a failure. About two years ago a former employee recalled a stringer of ore exposed in driving the crosscut, but which was not regarded of sufficient importance to follow, the ground being broken by a fault and hard to hold. This employee secured a bond and lease on the property and was successful in finding men with financial resources to develop it. Result, a lead-silver oreshoot 300 ft. long actually proved, which will probably prove to be much longer. It is this that is now being blocked out in preparation for a mill to be erected by the Golconda company.

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Consolidated Virginia and Ophir Option Ord Mine

Although the Consolidated Virginia and Ophir mines in Virginia City, famous producers of the Comstock Lode many years ago, are closed down, with little hope of either being reopened, the companies are alive, and President Zeb Kendall is looking for new and promising properties. Recently these two companies acquired an option on the Ord copper property, near Daggett, Calif., and machinery has already been shipped from Virginia City to the mine so that work may be started at once. The option was originally held by the Ord Mines Co., and considerable development work was accomplished before it was turned to the Consolidated Virginia and Ophir companies. Development, so far, consists of a 500-ft. shaft with workings on several levels.

To Cut Diamonds at Kimberley

STEPS have been taken to establish the diamond-cutting industry at Kimberley, South Africa. The Union government has entered into an agreement with an experienced firm in the industry and the municipality of Kimberley has allotted ground for the erection of a factory. Under the agreement, a number of apprentices are to be added each year to the factory's personnel.

Kimberley business men for years have urged the establishment of a local diamond-cutting industry, claiming that such an enterprise would be an assured success.

Stoping Method Changed at Quincy Mine

Retreating System Adopted—Repairs to No. 4 C. & H. Shaft Make Large Tonnage of Ore Available

TO CUT costs of mining at depth, the Quincy mine, in the Michigan copper district, will change its system of stoping in all new openings. The retreating, instead of the advancing, system of mining will be used. In each case, drifts will be driven to the boundary of the property and stoping then will proceed from the end of the drift back toward the shaft. This is the method used in Calumet & Hecla and some of the other mines in the district. It involves less timbering, inasmuch as the ground in stoped-out areas does not require support. It also simplifies and cheapens the process of ventilation, as air forced into the drifts is not dissipated through stopes near the shaft. In the advancing system of mining, which has been in vogue at Quincy, stoping is started just beyond the shaft pillar and carried along to the end of the drift. This method necessitates the use of a large amount of timber. Quincy has been using about 2,000,000 ft. of timber a year; and the cost of installation of this timber has been high. Lowering of the timber has cut the hoisting time and contributed to large labor and transportation costs. The retreating system of mining will, it is claimed, result in a saving of from 50c. to $1 per ton in ore-handling charges. Repairs in No. 2 shaft, which was damaged by fire, have reached the 39 level.

A large tonnage of rich conglomerate rock will be made available for recovery by repairs in the fire-damaged part of No. 4 shaft in the Calumet branch of Calumet & Hecla Consolidated. This work is proceeding below the 40 level and will be pushed through to 57 level, where the fire started. Gas in the shaft delayed the work and made progress slow for many months following the fire. Some of the richest rock ever cut in the conglomerate remains in backs of stopes, arches, and pillars above the 57 level.

Below the 81-level haulageway, No. 4 will continue to open the conglomerate vein at great depth. An electric hoist at the 78 level will be used, and the rock from depth will be trammed through the haulage tunnel to the Red Jacket shaft for hoisting. At the other end of the mine—the Hecla branch—No. 7 shaft will be used to mine the lode at depth. Levels driven north from No. 7 will connect eventually with openings from No. 4. In addition to this virgin ground, levels from the slope shaft, north of the Red Jacket, are opening the lode in the so-called "five forties," 45 per cent of the area already developed being available for stoping. Rich rock is being recovered from backs and arches in upper levels in No. 9 shaft, South Hecla. About 630 tons of ore a day is being mined and a large tonnage remains to be taken out.

Rich copper ore in the old Arcadian vein, which is being opened by Arcadian Consolidated in the New Baltic shaft, has given way to a finer mineralization, but this condition is quite characteristic of the Michigan copper-bearing lodes, in which the metallic content varies sharply. Openings have been extended 200 ft. north and 80 ft. south on the vein, which is still of good width.

Copper is again moving freely from the Michigan district. Rail shipments to Middle West points have increased lately and probably will reach 4,000,000 lb. for the month. Shipments by boat are expected to continue well into November.

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Alaskan Miners Grateful for "Wamcats"

The lives of two prospectors were saved by the Washington-Alaska Military Cable and Telegraph System, operated by the Army Signal Corps, according to a letter written by a miner working along Little Squaw Creek, in the Chandalar district—the most northern mining camp in Alaska. The letter, which was recently brought to the attention of the Secretary of War, reads as follows:

"Last winter two of the boys were prospecting on Tobin Creek, which is 12 miles from their nearest neighbors. They had two borrowed dogs. On the night of the twenty-second of December the owner of the dogs was awakened by them. He found a note tied around the neck of one of the dogs. On reading the note he learned that the two men had been blown up in an explosion. Everyone around that section was informed, and we rushed over two dog teams, and succeeded in bringing those boys over to Little Squaw. Now here is where the value of the Little Squaw wireless station came in: we were able to get in touch with Fairbanks and get instruction from the doctor, as well as a flying machine to take the boys to a hospital, saving their lives."

Many New Topics in California Mining Circles

Empire Mines Reduces Operating Forces —Kennedy-Argonaut Suit Comes to Trial in January

MOST noteworthy in California mining circles was the recent laying off of more than 100 men by the Empire Mines Company, which states that pending further development of ore the reduction in man-power will be maintained. Its neighbor, the North Star, has about completed the campaign of major development undertaken some two years ago and expects to connect its second winze through with a raise now being extended. An important orebody was discovered, and its further development is under way. Apparently the North Star has resumed its old time position as an active producer. All three of the important Grass Valley properties, the North Star, Empire, and Idaho Maryland, are making progress in breaking up the practice of high-grading. Local reports state that the Grass Valley Boundary mine is installing additional pumping facilities and that the Central Consolidated property of the Western Mines Consolidated, Inc., is preparing to begin exploration work.

The suit of the Kennedy Mining & Milling Co. against the Argonaut Mining Co. in the sum of $1,500,000 has been set for trial on Jan. 16, 1928. It is the outgrowth of the disastrous fire that occurred in the Argonaut in 1919, when the Kennedy company was compelled to flood its mine.

Feather River dredge No. 1, owned by C. H. Thurman and his associates, has been sold to the Shasta Butte Gold Dredging Co., a corporation recently formed by Lawrence Gardella, who is operating in Shasta County. The dredge is noteworthy for its long record of continuous service, dating from 1906. More than 31,000,000 cu.yd. has been handled and over $2,000,000 produced.

The German Bar claims on the Middle Yuba River, in northern Nevada County, have been sold to Thomas Stephans, of Bowman, Calif. The property is several miles from Alleghany. A road is to be constructed and a 10-stamp mill is to be erected. The Lecompton mine, an old property in the Willow Valley mining district, is being reopened by E. J. N. Ott and improvements made to the mill. A two-compartment shaft is being sunk on the Gracey property, another old prospect.

A growing interest in non-metallics is indicated by the location of claims aggregating some two square miles of a pumice formation near Mount Hoffman, in Shasta County. The deposit is at 7,000 ft. altitude, and about eight miles east of Medicine Lake.

At Whiskytown, Shasta County, the surface plant of the Ganim mine was destroyed by fire on Sept. 26. The Ganim was being worked upon a small scale and had been shipping an occasional carload of talc from a vein that was cut into several years ago while exploration was in progress. An eastern company has taken a lease upon the Bell Cow group in the French Gulch district of Shasta County.

The Alhambra Mining Corporation, of Gardnerville, Nev., has applied for a license covering a project on Crater Lake in Alpine County, Calif. It is proposed to erect a dam 47 ft. high and 264 ft. long to furnish a few hundred horsepower to be used in mining operations.

Russian Emerald Concession Purchased

A CONCESSION on the Ural emerald mines has been purchased from the Russian Soviet government by L. Heller & Son, of New York City, importers of precious stones. Under the terms of the concession the mines will be worked jointly by the firm and the Soviet government. The firm will furnish capital, American engineers and management, and finance the installation of any necessary new equipment. Working conditions and wage scales will be under the control of the government. The extent of operations is to be governed by the firm's ability to absorb the emeralds mined.

Non-Metallic Operations Increase in Arizona

ACTIVITY in mining non-metallic minerals in Arizona is increasing in several camps. The Arizona Asbestos Corporation, at Chrysotile, is adding a compressor to its equipment and will increase its payroll and production as soon as the installation is complete. The Sodium Products Co. is mining sodium sulphate at Camp Verde by means of a gasoline driven shovel.

Prehistoric mining implements have frequently been found in the Camp Verde sulphate deposit. Theodore Wingfield, assistant shovel runner at the pit, is the latest discoverer of relics. He has just added an Indian stone pick and handle to his collection.

The Squaw Creek Copper Co. has repaired the road leading from the Camp Verde highway to the mine and expects soon to start mining its molybdenite deposit. The company has arranged to have supplies hauled to the mine by the trucks of the Sodium Products Co.

The Chloride mill is making a test run on 1,000 tons of ore from the Twentieth Century mine, which is being operated by W. J. Murray, the owner of the testing plant at Kingman. As the mill handles 100 tons per day, the test will require ten days. The mill ordinarily receives the production of the Hidden Treasure mine, which has suspended stoping operations during the test run.

Tonopah Production Continues at August Rate

Low Price of Silver Makes Operations Not Very Profitable—Strike Made in Eureka District

PRODUCTION from the Tonopah, Nev., mining district for September was about the same as for August. Gross value of bullion shipped was estimated as $161,200. Probably $25,000 of this total came from the Divide leaser production, with scattered small lots from other nearby camps.

Of the total, Tonopah Mining and Belmont accounted for $72,000, Tonopah Extension $51,200, and West End Consolidated $38,300. The bullion contained 225,200 oz., valued at an average of 72c. per ounce.

At the present low price for silver, Tonopah operations as a whole are not very profitable. On Oct. 15 the West End Consolidated closed its 265-ton mill and in the future will ship its ore to the mill of the Tonopah Mining Co. at Millers, which now is the only custom plant in the Tonopah district. Reasons given for the closing of the mill were lack of ore in its own mine and decreased tonnage of custom ore, making it impossible to operate at a profit, for the present, at least. The West End is continuing work in the mine, both on company account and by leasing, and has about 35 men at work underground. The mill is not being dismantled and will be reopened when mine conditions and custom ores available justify resumption.

What promises to be an important strike has been made by the Moris brothers, in the Prospect Mountain section of the Eureka district, near the Diamond mine, on a quartzite-limestone contact. This discovery was made in a 450-ft. crosscut tunnel which cuts the ore about 400 ft. below surface, and it appears to open valuable stoping ground. The ore is said to contain gold, silver, and lead.

Eureka as a whole is rather quiet, with little work going on except that done by leasers. There has been active interest in ground ownership in the district, however, and a higher lead price would undoubtedly stimulate activity in mining.

New Equipment for 85 Mine, Near Valedon, N. M.

A new boiler and 750-kw. steam turbo-generator, to strengthen the equipment at the shaft and increase the efficiency of operations, are being installed at the 85 mine of the Calumet & Arizona Mining Co., at Valedon, N. M. The work is expected to be completed early next month. The 85 mine is doing considerable development work, in addition to maintaining an average output of between 8,000 and 9,000 tons monthly. The shaft is now down to a depth of 1,650 ft.

Placer ground along the Huanuni River

Placer Tin Operations of Increasing Importance in Bolivia

Richness of Lode Mines Causes Neglect of Placers—Only One Deposit Worked by Modern Methods—More Prospecting During Last Few Years

By Robert D. Ferron
Metallurgist and Mining Engineer

THE CHIEF tin production of Bolivia has always come from lode mining, and the mines in general have been so rich that the possibilities of the Bolivian tin placers have been rather neglected. Many placer deposits, however, are known; some are of fairly large size and of a probable tin content that compares favorably with the general run of such deposits in the Malayas. To date, only one placer has been worked by modern methods. The last few years, however, have seen a decided increase in placer prospecting. Placer tin now promises to become an increasingly important factor in the Bolivian tin output.

Distribution of the Deposits

In the accompanying sketch map the region containing the placer deposits is represented by the shaded area; this area corresponds roughly to that embracing the tin lode mines, though with some extension to the north, at least. Most of the placers have been formed by the erosion of veins now being worked as lode tin mines, or of former veins closely associated with present-day veins. Hence the placers are usually found on hill slopes or along valleys below and near the present operating tin mines.

Although tin lodes have not been discovered in Peru, so far as I know, placer tin is encountered in the Poto region, north of Lake Titicaca. Some of these placers were worked for gold by the Incas. One is now being exploited by a Peruvian concern, employing hydraulicking and sluicing methods. The tinstone is said to have been considered as a nuisance by the operators, since it filled up the riffles and increased the difficulty of gold recovery. The Vilaque River deposits are farther south, a short distance to the north of the city of La Paz, Bolivia. These placers lie in the foothills below the mountain of Milluni, which contains some of the mines of the Fabulosa company. The hills appear to be formed of material transported by glacial action from the high mountains above. The débris contained gold and tin, and these metals have been partly concentrated in the valley bottoms by subsequent erosion of the hills. Most of the small-scale work to date has been concerned chiefly with gold recovery. Below Araca, at the northern end of the Quimsa Cruz range, a few hillside tin placers have been worked in a small way. Farther south, the Yaco River valley, draining from the Chojñacota-Monte Blanco district, has been worked by the local Indians for many years. This work has been primarily for tin, though a little gold has been recovered also. Some few placers are known on the eastern slope of the range, but considering the importance of the Quimsa Cruz tin mines, surprisingly few and unimportant placers have been so far developed in the district.

Hillside placers have been worked on the slopes of Chicote Mountain to the south; and the Ayopayo River bed below carries unknown amounts of both tin and wolfram. No placers of importance have been yet developed in the Berenguela district, farther south. Around Oruro, so far as I know, little or no deep prospecting has been done, though it seems probable that tin might be found over some of the surrounding pampa, near bedrock. Small deposits are known in the Colquiri and adjacent districts, but they have been only slightly developed. The mountains between Oruro and Colquechaca contain numerous placers, nearly all of which are in small-scale operation at present. No gold is encountered this far south, but often wolfram, and sometimes even bismuth, occur. Nearly all the valleys draining from the mountain of Negro Pabellon contain placers that have been worked for many years. One of these is contained in the main valley below the Patiño and Duncan mines, and has recently been examined with a view to dredging. Across the hill, the Japo placers are being exploited in a small way, operations being carried on beneath a thick bed of mountain peat. Gulches to the north also contain deposits, and the Chiaraque Valley, draining toward Oruro, is worked by contractors. Most of these placers were formed by water concentration of glacier transported material from Negro Pabellon.

Farther south, the Morocacola and Huanuni river beds and benches have been worked for placer tin; particularly the latter, which is now being systematically prospected. These placers lie below the Morocacola and Huanuni tin mines. Numerous bench placers exist along the Huanuni River, in addition to the present river bed, which is probably a re-

Sketch map of Bolivia showing location of tin placer area

concentration of former higher placers. The slopes of the hills below the famous Llallagua-Uncia lode mines have long been worked for tin, which is found principally in enriched streaks near bedrock. More recently, placer tin has been discovered and worked in the big flats below Uncia, so that this district now holds considerable promise from a large-scale viewpoint. The Palca River, not far from here, also contains numerous placer deposits, both in the river bed and on hill slopes tributary to the stream. Placer deposits are also being worked in the Colquechaca and Ocuri districts and are of the same general type and worked in the same manner as those just described. In the Antequera-Avicaya region, hill-slope placers are being exploited by shafts and bedrock drifting. This deposit is somewhat unique in that the boulders composing it are prevailingly angular.

South of Pazna, a few placers have been mined in connection with some of the small mines. Farther east, in the Potosi-Porco district, many placers of importance are being worked. They are found on the slopes of Potosi Mountain and in the near-by Pilcomayo and Tarapaya river beds. One of these deposits is now being dredged by the Guggenheim interests with much success; other developments of importance may be expected from the district. The Chorolque district, farther south, is one of the oldest placer sections of Bolivia. Large hill-slope deposits are known here, but production is hindered through lack of water. The Chocaya district, farther

Working the Japo placer below a thick bed of mountain peat

west, contains placers that have been worked on a small scale. I know of no placers that have been discovered south of this, but it seems probable that prospecting may show placers near to, or across, the Argentine border.

Washington Letter

By Paul Wooton
Special Correspondent

Report from London of Effort to Peg Tin at £300 Denied

Washington, Oct. 23—A report, originating in London, to the effect that British, Dutch, and American tin interests are taking steps to peg the price of tin at £300 a ton for a year seems to have been made out of whole cloth for the purpose of stimulating buying. The price of tin has fallen from an average of 68c., early in the year, to an average of 61½c. last month. The tendency was still downward during the first half of October. November and December are months in which the minimum of buying is done.

Under such circumstances, speculators, anxious to boost the price, are thought to have circulated the report that a new control was about to be formed. Cablegraphic inquiries, however, promptly brought information from London that no meeting of tin producers was in progress and that no association is being contemplated.

While a tin control would be one of the most difficult for the United States to meet, some progress is being made in developing substitutes. A new alloy for industrial soldering purposes has great promise. Indications are that lacquers soon will be used for the coating of containers used for canning purposes.

Secondary Tin Increases

The salvage of secondary tin in this country has gradually increased to the record high of 28,600 long tons in 1926. It would appear, however, that the price of tin has little effect on the recovery of secondary tin, for in 1923, when the average price of tin was 42c. a pound, the recovery of secondary tin amounted to 26,973 tons, and in 1919, when the average price was 65c. a pound, the salvage of secondary tin totaled 21,485 tons. Moreover, last year the average price of tin was practically the same as in 1919 and the salvage of secondary tin totaled 28,600 tons.

Various Commission Affairs

The examiner in the case brought by the Federated Metals Corporation against the Pennsylvania Railway Company has recommended that the Interstate Commerce Commission find that the present rate on tin ore from New York Harbor to Pittsburgh is reasonable. He suggests that the Metals Corporation complaint be dismissed.

Proposed reductions in freight rates on borate from Amargo, Calif., to Texas Gulf ports for export have been suspended until April 1.

Briefs in the fluorspar case have been filed with the U. S. Tariff Commission by the following: William H. Muller & Co., of New York; Bethlehem Steel Co., Hazel-Atlas Glass Co. and the U. S. Smelting, Refining & Mining Co. In addition a brief has been filed by a committee representing the producers in the Illinois-Kentucky district.

R. D. Webb, of Minden, La., has applied to the Federal Power Commission for a preliminary permit covering a project on the Lake Fork of the Gunnison River near Lake City, Colo. He plans to construct a storage reservoir of 30,000 acre-feet capacity and to install 2,500 kw. The power is to be used for mining purposes.

Senator Oddie to Reintroduce Minerals Relief Bill

Senator Oddie, of Nevada, chairman of the Committee on Mines and Mining, has announced his intention to reintroduce his war minerals relief bill, involving claims totaling about $3,700,000, during the next session of Congress and to make every possible effort to bring about its enactment. The Senator described the issue presented by his bill as one involving the national honor and declared:

"There has been entirely too much of this thing of arbitrarily refusing to pay claims against the government which are morally and legally just, simply because to pay them means taking a little money out of the Treasury. If the claims are just they should be paid."

Supreme Court Dismisses Hibbing Suit

Without a written opinion, the United States Supreme Court, on Oct. 24, dismissed the appeal of R. C. Breen and others against Morton Denison Hull and others involving the closing of certain streets in Hibbing, Minn., so as to permit the Oliver Iron Mining Co. to make new openings into the ore deposits beneath that town. The citizens who protested against the action of other property owners in consenting to the street changes filed suit and lost in the state courts, which action will stand, as the United States Supreme Court decided that no federal question was involved.

Bureau of Mines Activities

Better to observe the high temperature reactions of oxides, a vacuum furnace of the high-frequency induction type has been built at the Bureau of Mines Berkeley station. The furnace has a glass top, which permits observations throughout the heating process. A special study is being made by the Bureau of practices in drilling and blasting drift rounds. A series of special test rounds were blasted in the Homestead mine under conditions particularly favorable for observation and study.

Because of the military importance of metals, both the Army and the Navy frequently transfer funds to the Bureau of Mines to permit of investigations of strategic minerals, and the Bureau is spending large sums each year in work on helium which is in the interest of the Army and the Navy.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Brokerage Houses Raided and Arrests Made in Ontario

TORONTO, OCT. 15.—The office of the Attorney General of Ontario is paying a great deal of attention to fraudulent stock-promotion schemes and high-pressure selling methods. During the last few weeks a number of brokerage houses have been raided and arrests made. Arrests in the case of Worthington & Co. and the hearing of evidence led to raids and the arrest of officials of the Toronto Securities Co., having offices in Toronto, London, and Windsor. In Montreal, J. W. Ball and C. F. Meikle were arrested and brought to Toronto for alleged conspiracy in connection with the shares of the Continental Refining & Smelting Co. Another Montreal broker, Irving J. Isbell, was also arrested in connection with the Eastern Metals & Smelting Co., and is now out on $30,000 bail. The Attorney General's department is making an active effort to clean up an unhealthy situation, and it is believed that action such as this should help to improve matters.

ONTARIO mining shares continue to be the center of attraction on the market, and, although there has been a moderate recession in the last week, prices continue to rule high. It is impossible to predict what the end of such a market will be, because as long as the public is unable to estimate the end of the period of expansion, increased profits and increased dividends, it appears willing to discount the future a long time ahead. In the meantime, however, it has been a harvest for the brokers and the investors. A seat on the Standard Mining Exchange, bought two years ago for $4,300, sold last week for $40,000. In many cases profits by the brokers and investors are much greater than the mine operating profits. It has been estimated that during the period of a year the Teck-Hughes mine made a profit of under a million dollars, though brokers trading in the shares made commissions of $500,000 and the stock had a market appreciation of more than $30,000,000.

During the past week better results have been obtained at the Tough-Oakes Burnside property in Kirkland Lake. In the course of sinking at a depth of approximately 1,500 ft., a new vein 10 in. wide, carrying free gold and tellurides, was encountered. Commercial ore has also been found in another section of the mine, and diamond drills have cut what is believed to be the faulted section of No. 3 vein. This was one of the most important veins of the property, and, in the early days of the mine, high-grade ore was found over the drift widths. Below the 200-ft. level, however, a fault was encountered, and what now appears to have been the wrong vein was considered to be the faulted extension.

In September Dome Mines treated 45,000 tons and recovered $326,622, or an average of $7.25 a ton. This is a slightly lower tonnage, and higher recovery per ton, than for several months. The company has declared the regular quarterly dividend of 25c. a share payable Oct. 20 to stockholders of record Sept. 30. Also, it has recently taken an option on a group of silver-lead claims in the Michipicoten district. The total purchase price is understood to be $200,000, on which an initial payment of $4,000 has been made.

Production from the Vipond mine in September was $51,400, from 7,422 tons milled, an average of $6.94 a ton. It is understood that operating profits are at the rate of approximately $15,000 a month. At the recent meeting of the Vipond, Dr. J. Mackintosh Bell, managing director, resigned from the board and will confine his activities to acting as consulting engineer. The group controling the Vipond also controls the Pioneer, which is operating the Minto and Jubilee properties in Michipicoten. Final payments on these options have now been made, the purchase price being $60,000 for the Jubilee. It is understood that in the immediate future the Pioneer will make an offering of shares at 50c. each, giving shareholders the first right to subscribe. In the event of the full number not being taken up, the balance has been underwritten.

California Gold Thefts Attract Attention

MUCH difficulty is being experienced in California in preventing thefts of gold ore and gold amalgam by miners from the mining companies in spite of the operation of a new law which makes obligatory the registration of all gold-buying transactions. So long entrenched is this business that continued efforts are only now beginning to get results. Recently an assayer of Grass Valley, Calif., was convicted and made to pay a substantial fine. Two other gold buyers in the same city, upon complaint by three mining companies, were cited to appear before the state mineralogist, who is responsible for the prosecution of offenders. The complaints charged the defendants with buying gold from miners and falsification of their records.

A vigorous fight is being waged, but under difficulties. In the opinion of those familiar with conditions, only by persistent effort on the part of the mining companies and the public officials can any progress be made in stamping out the evil, which makes serious inroads upon the companies' incomes. Assayers who provide a market for the stolen gold are considered particularly reprehensible and deserving to be put out of business.

Mexico City Letter

BY W. L. VAIL

Special Correspondent

Principal Mining Districts Unaffected by Attempt at Revolution

MEXICO CITY, OCT. 11.—The short-lived attempt at revolution, which started with a mutiny of troops in the Mexico City garrison on the night of Oct. 2, though evidently nation wide in its conception, has not affected any of the principal mining districts up to this date. Advices from Oaxaca, Pachuca, Jalisco, Zacatecas, Chihuahua, and from along the entire West Coast of Mexico state that nothing has happened of a revolutionary nature. Some scattered prospectors in Guerrero were "shooflied" into the more populous centers for a few days. Conversation regarding an uprising had been heard for months, and the results have demonstrated at least that the general public is absolutely apathetic. With the exception of political opponents of the government, the mass of the people evidently prefer to work rather than aid in a revolution.

The registry division of the Department of Mines is many months behind in clerical work, as a result of the filing of more than 15,000 registration applications between Aug. 3 and Aug. 20. Although no formal extension for the time of filing has been announced, it seems to be the policy of the officials to be easy with delinquents because of the congested conditions in the department.

The Matulera mine, in the district of Ocampo, State of Chihuahua, was reopened recently, and 300 miners are reported to be at work preparing the property for exploitation. About 40,000 pesos have been expended in machinery, and a small mill has been erected at San Ramon, near the property. The opening of the Matulera has revived interest in the Ocampo district, practically all of which is highly mineralized.

REPORTS from Sonora state that another important orebody has been discovered on the properties of the Greene-Cananea Copper Co. The new strike parallels an important discovery made more than a year ago. Although development work and actual mining has been considerably reduced at Cananea, a great deal of exploration is in progress. Reports that the Yaqui campaign has been practically closed have led a number of prospecting parties to go into the mountains near the Yaqui country, which in some regions is highly mineralized.

A new federal labor bill now being discussed before the Mexican Congress is being watched with a great deal of interest by the various mining companies. It appears to be the general impression that the bill, if passed as sent to Congress by the president, will be acceptable to all classes.

Melbourne Letter

By Peter G. Tait
Special Correspondent

Australian Tin Operations in F.M.S. and Siam Successful

Melbourne, Sept. 16—According to A. W. Palfreyman, who is a large holder in Australian tin companies operating in the Federal Malay States and Siam, Australian companies have invested £5,000,000 in the industry. Approximately half that amount has been paid in dividends, and royalties amounting to £800,000 have been paid to the governments of those countries. Many new companies are preparing for the producing stage and others are testing new areas. At present companies require areas containing at least 25,000,000 cu.yd. available and averaging 1 lb. of tin oxide per yard, but the time will come when ground of lower grade will be taken up.

Dr. W. G. Woolnough, geological adviser to the Australian government, has gone to Papua to report on oil boring operations. Referring to his recent visit to Central Queensland, he said that he went in a pessimistic frame of mind as to the prospects of oil being found there, but he came back enthusiastic.

WHAT may be described as a most favorable indication of the occurrence of oil has been discovered at the bore of the Lakes Entrance Development Co., Ltd., Lake Bunga, on the southeast coast of Victoria. Samples of a core taken from No. 2 bore have been examined by J. C. Watson, chief chemist of the Victorian Department of Mines. According to his report one sample contained a heavy asphaltic-base petroleum. The core was obtained from a depth of 1,230 ft. Although the analysis shows only a small percentage of oil, it is sufficient to justify further boring operations in the hope that it may be found in commercial quantities. Boring is being continued.

The present low price of lead as compared with the average of the last few years is causing serious concern to Australian producers. As indicated in my last letter, the Broken Hill Proprietary Co. has issued an announcement that mining and treatment operations will cease on Sept. 24. The Block 14 Co., whose ore is treated by the Proprietary, will also close down. It is of interest to record that in thirty-four years the Proprietary mine yielded 173,451,037 oz. of silver, 1,279,334 tons of lead, and 102,857 oz. of gold. It paid to its shareholders £10,564,388 in cash dividends, £568,000 in cash bonuses, £576,000 in cash from flotation of the British Broken Hill Proprietary Co., Ltd., and £1,744,000 in shares in the companies floated from the parent company —a total of £13,452,388. It distributed £13,348,560 in wages. More than 1,200 men will be affected by the closing of the Proprietary and Block 14 mines. Since 1915 the Broken Hill Proprietary has devoted more attention to iron and steel than to silver and lead.

The North Broken Hill Co., which owns the North and British mines, is planning to close the British mill and concentrate treatment operations at the North mill. How long ore extraction from the British mine will be continued depends on the trend of the metal market. The other principal mines, the South, Central, Zinc Corporation, and Junction North, will probably continue to operate unless the price falls to an unpayable level. The Pinnacles, an outside property owned by the Junction North, has been closed down.

Natural gas was discovered at Roma, Queensland, about twenty years ago. Subsequently the flow of gas was blocked. In the present bore, which is within seven chains of the original bore, gas was met with at 3,685 ft., and tests of gasoline content are being made. On the earlier occasion the gas was proved to contain 150 gal. of petrol per 1,000,000 cu.ft. Whether the gas flow indicates the occurrence of oil in commercial quantities remains to be proved.

Manganese Operations Expand at Two Properties

The M. R. W. Mining Co., of Memphis, Tenn., recently took over the Casson manganese mine in the Batesville-Cushman manganese field of Arkansas, and has just put a small experimental or pilot mill into operation on Miller Creek. Operations are in charge of Joe Reed, a mining engineer of Memphis, who also has an interest in the company. The ore at the Casson mine is in the form of buttons, disseminated through the Casson shale. The mill has a capacity of handling 40 tons of crude ore per shift. Plant equipment consists of regular jaw crusher, rolls, four rougher jigs, and five cleaner jigs. Fines are cleaned on a table. The mill, in fact, is just a small zinc-concentrating plant, and is handling the ore successfully. Fifteen tons of concentrates are recovered per 100 tons of ore treated, and the concentrates run from 37 to 40 per cent metallic manganese. Mr. Reed states the construction of a large mill that will handle 200 tons of ore per shift will be started soon. The mill will be built on the same general plan as the pilot mill.

According to John Cole, president of the Domestic Manganese & Development Co., of Butte, the plant will be ready for operation by Dec. 1, and will have an initial capacity of 300 tons of concentrates per day. The supply of ore will come from the Travona and Ancient mines of the W. A. Clark estate, from the Emma mine of the Butte Copper & Zinc Co., and from mines in Philipsburg, controlled by Mr. Cole. Ore assaying as low as 20 per cent manganese will be handled, and the pink manganese concentrates, when roasted, will assay over 50 per cent.

London Letter

By W. A. Doman
Special Correspondent

Doubtful Whether City Deep Can Maintain Current Dividend Payments

London, Oct. 11.—Conditions in the City Deep appear to be far from satisfactory, and, although reports of recent good developments may serve to keep the price of the shares steady, the relation of crushing results to developments cannot be ignored. The mine is now working at a depth of 5,825 ft., and the value of the ore reserves has steadily declined during the last three years from 8 dwt. to 6.3 dwt. per ton. For the nine months of the current year the average of the ore crushed has been 6.73 dwt., or in excess of the reserves. Full details of developments for 1927 to date are not available, but for the first half of the year the new ore opened up was of the value of about 6.3 dwt. When it is remembered that working costs are now 26s. 8d. per ton, or equal to 6.25 dwt., it is difficult to see how any great margin of profit can be forthcoming, especially when London and other overhead charges are taken into consideration. The company paid dividends amounting to 17½ per cent during the last year.

ALTHOUGH good progress is being made by San Finx Tin Mines, in northwest Spain, the results so far obtained are not up to the estimates given in the prospectus issued about twelve months ago. For the first eight months of the current calendar year, 23,663 tons of ore was treated, yielding 15.8 tons of black tin and 62.3 tons of wolfram.

When the Sub Nigel took over the lease of the adjoining Grootfontein area, early in 1926, the agreement with the government provided for an increase of the capacity of the plant to 18,000 to 20,000 tons per month and the expenditure of £350,000 (including £80,000 for extension of plant) during the first four years on developing and exploiting the southern part of the leased area. At the end of the four years the company was to decide whether the sinking of a further shaft and the outlay of the balance of the estimated expenditure were warranted. The plant has been dealing for some time with nearly 20,000 tons per month, and developments under the direction of the consulting engineer, W. E. Turvey, have been of so satisfactory a character that it has been decided to provide the necessary working capital to carry out the agreement, nearly two years ahead of time, so far as shaft sinking, equipment, and plant extension (up to 25,000 tons per month) are concerned. The capital is to be increased to £750,000 by the issue of 142,500 10s. shares at £3 10s., to be offered to shareholders in the proportion of one in ten.

Societies, Addresses, Reports

Long-Time Guarantees of Prosperity

An Address Before the
Chicago Association of Commerce, Oct. 19, 1927

By Edward J. Mehren,
Vice-President of the McGraw-Hill Publishing Co., New York

MY PRESENCE on your program is a compliment to America's business-paper publishers who have been meeting in Chicago this week. It is no light honor to receive the consideration of you men, the creators of the new Chicago—the Chicago whose spiritual reach is shown by the strength of your universities and other cultural institutions, and whose vision and achievements have tangible testimony in such works as the Boulevard Link, the Wacker Drive, Grant Park, and the towering structures of the business center. On behalf of the publishers I express their appreciation of the honor you have done them by asking one of their number to speak to you today.

I have elected to speak today on prosperity. It is one of our most active topics. Can we maintain it? Can we go to ever higher levels? Or have we reached the top and must we soon retire to less active business and a lower standard of living?

There are obviously many factors in making prosperity, and, if exact definition be insisted upon, one must admit that there can be no absolute guarantee of unbroken high-speed business. But there are certain fundamental factors so deep and broad in their influence that there seems no better synonym than the word I have used.

It is all the more important that we appreciate these fundamentals at the present time, for we are in a period of severe test of business and business men. We are in an era of large, though now declining, volume of business, but of falling prices and narrowing profits. True, the price index has recently turned upward, but the business man who plays safe will remember the price trend after the Civil War and make his plans on the assumption of a long though gradual decline. In such times one needs to go back to fundamentals.

America's Production

To begin with, let us get a picture of America's recent industrial development. The last United States census of manufacturers showed that the volume of our manufactured goods in 1925 was $2\frac{3}{4}$ times that of 1899, but that the number of men employed was only 1.8 times as great. In other words, there has been a great increase in output per worker; in fact, each man now produces 50 per cent more than he did in 1899. The reason is that we now use $3\frac{1}{2}$ times as much power as we did 28 years ago. We have transferred the work of industry from the backs of men to the inanimate forces of steam and electricity.

As a result of the use of power and machinery, therefore, 67 men now do as much work as 100 men did before. If today we produced only the same kinds of goods as in 1899, the country could not absorb them, for the population has increased only 54 per cent, whereas the goods production is $2\frac{3}{4}$ times as great. True, with a higher standard of living, people formerly in poverty would buy more staples, but the demand would not absorb the entire 33 per cent of labor thrown off by the staple industries. We should have one of two things, or a combination of them. We should have large unemployment, with resulting poverty and its attended discontent, or we should be dividing among 100 the wages that now go to, say, 67. In the latter event, we should have a lower standard of living, on account of the reduced purchasing power per capita. In either event, instead of prosperity we would have industrial stagnation, the ills of over-population, and all those serious social problems that beset England, and those with which Mussolini is grappling with an iron hand.

Where, then, have gone these men thrown off as surplus labor by the older industries? The answer is that they have gone into new industries and are making products undreamed of in 1899. That important phenomenon is at the bottom of our prosperity, and, if we understand how it has occurred and what has made it possible, we shall know some of the long-time guarantees of prosperity.

What are these industries that have kindly come along and absorbed our surplus labor and substituted prosperity for industrial stagnation and social disorder? They are numbered by the score, but let me mention only three. The automobile business, unknown in 1899, sold over $3,000,000,000 worth of new cars and trucks last year, while probably another $3,000,000,000 was paid for used cars, accessories, gasoline and garage bills. The radio industry in five years grew from nothing to a sales volume of over $500,000,000, and rayon, dating back to infant beginnings in 1910, sells today at the rate of 74,000,000 pounds per annum.

As children we marveled at the fabled tales of Aladdin's lamp. Here is something in our day more wonderful because it is real. We rub an idea with the genius of American organizing ability, and lo! an industry grows before our very eyes, even as the Hindu fakir's tree grows in a few minutes. This growth of new industries is, indeed, a wonder. But another wonder is needed in order that the first one may be. Marvelous that the goods can be produced. Equally marvelous that they can be absorbed or consumed.

Radio, for example, comes on the market. It is sold to the whole people in five years. The national mind in that brief period becomes radio conscious, and accepts the new product as a normal element in our community life. In this absorptive power, in this receptive power, lies the fundamental secret of American prosperity. We have a market of extraordinary receptivity and adaptability. To us that no longer seems remarkable. We live with it. It seems as though it could not be otherwise. But it is extraordinary—truly a wonder. For contrast, look at the Old World, with its lower level of receptivity and its inevitably lower standard of living. So did their fathers; so will they do. As a result, while the European merchant fights feverishly for foreign trade, a market of tremendous potentiality—the home market—lies undeveloped at his very feet.

Developing Receptivity

The first long-time guarantee, then, of prosperity is the preservation of this adaptability and receptivity of the American people. The primary means of preserving it is to continue to raise the level of intelligence of our people, and this demands a continuance of liberal support of our educational system. A second means of preserving this receptivity is to give the public an opportunity to exercise this faculty. If they never have anything new, they will be content with the old. We must expect—yes, we must foster—a continuous increase in the purchasing power of both the salaried and wage groups. But on this subject I shall have more to say in a few minutes.

Research

Here, then, we find a market of remarkable receptivity. It is obvious that we must supply it with more staples and particularly with new goods. Design of present goods must constantly be improved, but that is not sufficient. We must go behind the design room; we must go to the research laboratory, where radically new products and processes are discovered. *There* we will find, rather than in the design room, another long-time guarantee of prosperity.

For a moment let us get an idea of what research can mean to an industry. The whole electrical industry is built on the research laboratory. Out of it have come the modern electric

generator, high-tension transmission, long-distance telephony, radio, wire and wireless transmission of photographs, and a hundred other wonders, too technical to interest the layman but essential to the functioning of the electrical devices that we do know.

The chemical industry, too, rests on the laboratory. Need I do more than mention aniline dyes, rayon, bakelite products, dry-ice, nitrocellulose lacquers of the Duco type, petroleum cracking, the fixation of nitrogen from the air, and the liquefaction of coal into oil.

But research has another and vital purpose—namely, to decrease the cost of production and thus the selling price. And of that I shall have more to say later.

Today research penetrates into nearly every industry. Great is the satisfaction that we have made a start; greater still the certainty that undreamed of triumphs lie ahead—triumphs that shall eclipse the past. The higher the plateau, the farther we can see; and so it is with the research worker. In no industry is research anywhere near the volume that the engineers, scientists, and chemists can profitably lay out.

Pure Research

This research, with which we are fairly familiar, may, for convenience, be called industrial research, for it aims at definitely conceived objectives. It is good, but far from sufficient by itself. Back of it must be another type of research, deeper in character, concerned with pushing back the boundaries of the unknown. It explores. It finds new lands in the domain of science. It breaks up matter and determines its law. It subdues forces. Here in this field will be written the great future romances. Before giant electric power units could be, there had to be the work of Ohm, Volta, Henry, the physicists who determined the laws of electricity; before radio there had to be Clerk Maxwell, the mathematician, and Hertz, the physicist; before the automobile, there had to be Carnot, who determined the law of the heat cycle on which the automobile engine is built. Industrial research, then, stands on the shoulders of pure research—on the work of the physicists and the chemists. In well-organized laboratories the two types of inquiry go together. It is often hard to tell where the one leaves off and the other begins.

I make no apology for pleading with you, bankers, industrialists, merchants, for bounteous support of research. You are building for the future. It is your hope that the businesses you are rearing will pass in vigor to your business heirs. I hold out to you a promise: future industrial success—if you employ research; and I hold out a threat: industrial lameness and decay, if you neglect it.

So now we have two long-time guarantees of prosperity: First, the maintenance of a receptive market, and, second, research for the creation of new products. Then what? Obviously, the receptive market must be able to buy the new products as well as more of the old. That brings us to the question of purchasing power.

It should be evident that if we merely maintain our present purchasing power we cannot take new goods in addition to the old we are absorbing today. It is absolutely necessary, therefore, that the public's purchasing power must constantly grow larger. The old grumbling against an apparently too prosperous salary and wage group must give way to the appreciation that well-paid workers are good customers, and that good customers keep the factory wheels moving. Aye, more, a halt in the increase in purchasing power will bring industrial distress, for it would then be impossible to absorb into new industries the men released from the old.

There are two ways of increasing purchasing power: First, by reducing prices so that the present salary and wage dollar will buy more goods, and, second, by increasing the number of salary and wage dollars. We are using both methods in this country. Improvement in management, elimination of production wastes, simplification of varieties in all manner of products, standardization of materials and parts, and last, but not least, research—all these are mechanisms that we are applying, and that lead to lower production costs, lower selling prices, and constantly higher purchasing power of the dollar. Obviously, when I speak of lower costs I am speaking relatively, using the assumption that all values be taken in terms of 1913 dollars.

In addition, we have increased the number of salary and wage dollars faster than the increase in the cost of living. More and more we are abandoning the theory of the "living wage." We believe in something more liberal, in what I call a "security wage," a wage that provides not merely a decent living, but enough margin to own a home, to educate the family, and lay up savings that will secure the worker against the fears of unemployment, sickness, and old age. To make such provision for himself and his family is the natural ambition of every healthy-minded man. To be content with less is to reduce one's self to a definitely inferior social order. To be content with less is to accept dependence rather than freedom, and freedom, economic as well as political, is the proper ideal of every American.

An additional large advantage of having well-paid salary and wage earners is the industrial co-operation that results. Well-paid workers, under wise leadership, are ambitious, saving, and contented, and help reduce production costs. The combination of such workers, fair-minded capital, and efficient management makes an impregnable industrial system.

The next step after increasing purchasing power is to provide for the economical flow of goods from the manufacturer to the public. Manufacturing economy requires mass production, and mass production requires mass distribution. Here we come back to research. The area for the recovery of wastes in distribution is possibly larger today than in production, but it will yield economies only by experiment, study, and research. The field is tremendous, and again I plead for your generous support of research, this time of research in distribution. Further, I would let modesty and restraint do you an injustice did I not point out the need for still wider understanding of that "sword arm of business," advertising, which creates wants and mass demands, and is the channel through which knowledge of new products becomes known to the buying public.

The Circle

We have then, this recurring sequence: we use continually more power and machinery, and as a result increase the output per worker. This, in turn, has two effects: First, it increases the worker's earnings, and, second, because fewer men are needed throws off a surplus of labor. This surplus must, then, find employment in new industries whose product will be bought by the workers whose earnings have been increased. The crux of the situation, then, is to continue to increase the output per worker and to find new products to absorb the surplus labor thrown off by the older industries.

The process obviously proceeds in a circle, but in an ever-widening one. We increase output and earnings per worker and create a labor surplus. This surplus is absorbed by making new products which are then sold to the workers whose purchasing power has been increased. Obviously, the swing of the cycle will slow down if we do not add energy from time to time. It is like a stone swung in a circle at the end of a string. The flip in our case is research.

Naturally, there are other factors that affect our prosperity. I have mentioned two of them—the receptivity of our people and the effective use of advertising as a means of creating demands. There are many others. Their discussion in a short address would be confusing, even if possible. Those I have chosen, though, are fundamental. Their understanding will go far to keep up a general upward trend, even though from time to time there may be recessions, even as the one we seem to be going into just now. I hold out no panacea, no guarantee against occasional recessions. My subject was deliberately chosen as the long-time guarantee, and the fundamentals I have developed seem to me to deserve such description.

An Objection

I am fully aware that the difficulty of constantly increasing consuming power at a rate sufficient to absorb the goods that can be produced has been stated with piercing force in the last few years by Foster and Catchings. The difficulty is a serious one and not

to be lightly brushed aside. They point out that the consuming power is put out of balance with the producing power, first, by the abstraction from the circle of corporate and personal savings, and, second, by the fact that such savings instead of going into consumers' goods go into capital goods and so further increase productive capacity and still further disturb the balance between production and consumption. It is notable, though, that the one tangible avenue of escape that these investigators point out lies in the constant development of new industries, very rapid expansion of existing ones, and price reduction through production economies. We are, therefore, on solid ground, even in the face of their discovery, when we insist on the necessity of research. It is research that gives the new urge for the widening of consumptive power. It reduces costs and so increases consumptive power; it discovers new products.

Let me suggest that the great merit of the work of Foster and Catchings is that it makes apparent the dire need for facts so that we can by degrees approximate that fine balance between consumptive power and productive capacity which will go far to iron out the rise and fall that make the business cycle. To this subject we as business men must give a sympathetic ear. Now the relation is a haphazard one. We do not know at any given time how much new capacity can be absorbed by consumptive demand. We know only that over long periods such huge developments as transcontinental railway construction and the automobile industry have brought us great prosperity.

Agencies That Can Help

In all of these matters we fortunately have a number of agencies that are helping and that supplement individual and corporate effort. They will go far to safeguard us if we know how to use them. I refer, first, to the trade association; second, to government departments; third, to the universities; and, fourth, to the business press. Of the trade association I need hardly speak. Its service in fostering sound trade practice, encouraging research, and carrying on joint propaganda are of the very marrow of American business. It forms an excellent agency for joint research when one group of laboratories can serve all, or when individual businesses are not "sold" on separate research activities. Of the government departments, let me recall the service of the Bureau of Standards and the Bureau of Mines, and particularly of those newer bureaus developed under that extraordinary business statesman, the present Secretary of Commerce.

The universities make a contribution all too little appreciated. The industry that lacks contact with the university today is doing itself an injustice. There they have in the making the business men of tomorrow, your successors. There they have a fine enthusiasm for research—typified in a splended way by the Engineering Experiment Station of your own State University—the University of Illinois—which, I am proud to say, is my own Alma Mater. They are studying distribution with the advantage of detachment from the drive and the detail, and are trying to deduce laws that will help you and me.

There is finally the business press, which is business articulate, the instrument for welding all phases and branches of each industry or trade into a harmonious, homogeneous whole. It is an agency for interpreting business, its trends and problems, to business itself and other groups of the community. It is a medium for exchanging ideas on these vital problems I have discussed, cost reduction and research, and, finally, it is the chosen instrument for clarifying, crystallizing, and expressing the ideas and objectives of industry and trade.

Conclusion

If, then, the discussion we have gone through together be sound, it is the responsibility of all American business executives to give generous support to cost-reduction efforts and to industrial and scientific research. They must have faith in the receptivity of the American people and a knowledge of the use of advertising to take advantage of that receptivity. Above all, they must support research in their own corporations, in trade associations, and in the universities. We will most certainly continue to increase our industrial capacity. If we fail to discover new products at a rate sufficient to absorb surplus labor we shall have to divide the fruits of industry between a larger number of workers, our purchasing power will decline, and our standards of living drop to lower levels. If we can find new products at a sufficient rate we shall be able to absorb the surplus labor and continue our upward march.

Arizona Chapter Holds Meeting at Globe

Discusses Presentation of Technical Papers as Proper Function of Mining Congress

MORE than a hundred members and guests attended the fall meeting of the Arizona chapter of the American Mining Congress which was held at Globe, Ariz., on Oct. 10 and 11. The morning session on Oct. 10 was devoted to a short business meeting, after which a number of technical papers were read. There was considerable discussion as to whether or not the presentation of technical papers was a proper function of the Congress. Supporters of the A.I.M.E. claimed priority of rights in this field, and objected to the competition of the Congress, since nearly all the members of the Congress belong to the Institute and the latter is well equipped for publishing technical papers in pamphlets or in the transactions. Supporters of the Congress evinced a determination to continue presenting papers on operating problems. Delegates to the meetings of the Congress usually wish to take advantage of their visits to the districts where the meetings are held by making inspection trips to the mines and plants. They state that these trips are rendered much more informative and profitable if papers about the different plants are first presented.

The following papers were presented at the Globe meeting, and were very enthusiastically received:

"History of the Development of the Undercut Caving Method of Mining," by Felix McDonald, mine superintendent, and J. L. Johnson, assistant mine superintendent, Inspiration Copper Co.

"Engineering Features of the Undercut Caving System of Mining as Applied by the Miami Copper Co.," by A. J. McDermid, development engineer, Miami Copper Co.

"Slime Filling for Extinguishing Mine Fires," by H. S. Duncan, chief mine engineer, and A. H. Shoemaker, geologist, Old Dominion Mining Co.

"Re-treatment of Concentrates at Miami Copper Co.," by H. D. Hunt, mill superintendent.

"The Inspiration Leaching Plant," by H. W. Aldrich, superintendent of the leaching plant.

"Reverberatory Practice at Magma," by J. H. Rose, smelter superintendent, Magma Copper Co.

In addition to the technical papers and trips, the entertainment included luncheons, banquets, and numerous surface observation trips, and a golf tournament. The Miami Copper Co. entertained thirty guests underground, at a chicken dinner in the foremen's lunch room.

Irrigationists Favor Hydraulic Miners

THE manager of the Nevada County Irrigation District of California, A. L. Wisker, addressed the Commonwealth Club's Section on Mineral Resources on Oct. 4, upon the subject of hydraulic mining in relation to the irrigation interests of his district. Mr. Wisker advocated the fostering of both agriculture and mining, and pointed out that under proper safeguards both the farmer and the hydraulic miner could operate without interference. He showed that by co-operation with the irrigation interests, the hydraulic miner could obtain sufficient water to mine a considerable yardage, but that, unless mining operations were initiated speedily, the increasing demand for water would be such that the hydraulic miner could not afford to pay the price for the water that he would require. He pointed out the need for haste in perfecting arrangements for mining. Also, he stressed the fact that irrigation interests needed at this time the assistance of the miner.

C. E. Grunsky, Arthur Jarman, J. D. Stewart, and R. H. Elliott took part in the discussion that followed. The most interesting feature of this was the consideration of the débris slope to be assumed in calculating the storage capacity of restraining dams.

S. G. Blaylock to Receive Douglas Medal

S. G. BLAYLOCK, managing director of the Consolidated Mining & Smelting Co. of Canada, will be the recipient in 1928 of the James Douglas medal awarded annually by the American Institute of Mining and Metallurgical Engineers for distinguished achievement in non-ferrous metallurgy. The selection, made by the medal committee, headed by W. H. Bassett, was recommended to the directors and approved by them at the regular monthly meeting in New York on Oct. 12.

S. G. BLAYLOCK

Mr. Baylock is a Canadian by birth, and was graduated from McGill University in 1899. He started his professional career as assayer for the Canadian Smelting Works at Trail, which have grown into the huge metallurgical plant of which Mr. Blaylock is the guiding spirit today. From 1908 to 1911 he was superintendent of the Sullivan mine, the source of the major portion of the ore that supplies the Trail reduction works. Subsequent promotions made him assistant manager and general manager for the company. Some of the members of the nominating committee believed that it would be particularly gracious and appropriate to honor a Canadian at this time, and for this added reason they feel that Mr. Blaylock is a happy choice. The committee compliments Mr. Blaylock for his success in maintaining a competent and loyal organization and for his tenacity of purpose in sticking to a task that seemed to be wellnigh impossible of solution, which, of course, alludes to the development of a successful process for the treatment of the Sullivan ore. It also commends his generosity in sharing results and co-operating with other companies that have had metallurgical problems more or less similar in nature.

The specific achievements in metallurgy for which the award is made are enumerated by the committee as follows: "For his development of a selective flotation process for lead-zinc-iron ores; for his part in the development of the leaching of zinc ores and the electrolytic deposition of zinc; for his improvement in lead blast-furnace practice obtaining high lead recovery from flotation concentrate, producing high zinc slags; for his success in solving the problems necessary for the treatment of the ores of the Sullivan mine; for his development and improvement of the Betts process for lead refining; for the laying out and successful operation of the Tadanac plant to carry out the very complex metallurgical operations which the handling of the Sullivan ores entails."

San Francisco Section Hears Talk on Non-Metallics

G. Ray Boggs States California Plants Are Making Effort to Develope a High-Grade Firebrick

ON OCT. 11 the San Francisco section of the A.I.M.E. held its regular session. G. Ray Boggs, of Death Valley Junction, Calif., was the speaker of the evening and discussed the subject of non-metallic minerals and clays. Mr. Boggs said that although common firebrick is being produced in sufficient quantities in California to satisfy Coast requirements, efforts are being made in three or four plants to develop a high-grade firebrick, but it has been difficult to get suitable clays locally. Such clays have been found in San Diego County, and firebrick of high rating has been placed upon the market. Likewise quartz, clays and feldspar for white and sanitary wares have been developed, and, with the addition of from 10 to 20 per cent of English ball clays, suitable mixes have been made. The Great Basin, he said, has more non-metallic minerals than any other similar area in the world. Borax is the most important commodity now being produced from this area. The plant and mines of the Pacific Coast Borax Co. in the Death Valley area have been closed because borax can be produced more cheaply from "Rasorite," a new borax mineral found in a huge deposit near Kramer and now being exploited by that company.

To produce borax the new mineral is dissolved in hot water and recrystallized. The deposit is at a depth of 400 ft. and averages about 60 ft. in thickness. There is sufficient to supply the world for a hundred years. Attempts to utilize colemanite, which is not now of importance, for borax, are being made by using it as a substitute for salt glaze in manufacturing sewer pipe.

Prof. Andrew C. Lawson, who had just returned from Australia and had previously made a trip to South Africa, discussed the Permian glacial geology, which is apparently much more extensive than anything known in Pleistocene times. Philip R. Bradley reviewed the present status of mining in Alaska and stated that future metal mining discoveries in that area can hardly be expected to keep pace with the exhaustion of the properties now being worked.

George Otis Smith Will Head A. I. M. E. in 1928

GEORGE OTIS SMITH, director of the U. S. Geological Survey since 1907, will be president of the American Institute of Mining and Metallurgical Engineers during 1928, barring the exceedingly remote possibility that an opposition ticket might be placed in the field and elected over the candidates named by the official nominating committee. This committee, headed by R. V. Norris, has named the following ticket to be placed on the official ballot that will be sent to the members by mail before Jan. 1, 1928:

GEORGE OTIS SMITH

For director and president—George Otis Smith, District 4.

For director and vice-president—W. H. Bassett, District 1.

For director and vice-president—George D. Barron, District 0.

For directors—H. C. Bellinger, District 0; Robert E. Tally, District 9; Karl Eilers, District 0; J. V. W. Reynders, District 0; H. G. Moulton, District 0.

Mr. Bassett is technical supervisor for the American Brass Co.; Mr. Bellinger is vice-president of the Chile Copper Co.; and Mr. Tally is managing director of the United Verde Copper Co. with headquarters in Arizona. The other gentlemen are residents of New York who have various mining interests and have long been associated with the administration of Institute affairs.

South African Society Holds Meeting

At the monthly meeting of the Chemical, Metallurgical and Mining Society, held in Johannesburg on Sept. 17 the following papers were read: "Methods of Eliminating Barren Rock From Ore at the Sub Nigel Mine," by W. A. Quince; "Telescopic Mine Props," by H. W. Adler, and "The Use of Hole Directors in Jackhammer Stoping," by H. Simon.

Recent Technical Publications

"Phosphoric Acid, Phosphates and Phosphatic Fertilizers," by Wm. H. Waggaman and Henry W. Esterwood. The Chemical Catalog Co., New York City. Price $7.50.

This book is a recent addition to the rapidly growing list of books comprising the American Chemical Society Monograph Series. In conformity with the purpose of each of these monographs, the stated subject is covered comprehensively and yet in sufficiently simple form to enable the reader who is not a specialist to understand it easily. The book discusses natural phosphates, including bone, guano, apatite, and phosphate rock, but the section of greatest interest to geologists and mining engineers will be chapters 2 and 3, dealing with the phosphate-rock deposits of the United States and foreign countries. Methods of producing the so-called available phosphates are described, as is also the manufacture of water-soluble phosphates so widely used in agriculture. One chapter is devoted to the sulphuric-acid process of phosphoric-acid manufacture, and another to the volatilization process. Various applications of phosphoric acid and phosphates are described in considerable detail. They are utilized in baking, water softening, rust proofing, glass and ceramic products, beverages, cements, sugar refining, and in various other industries. It is emphasized that with development of the pyrolytic method of manufacture, phosphoric acid may become of increasing importance in industry, replacing sulphuric acid for certain purposes. An appendix gives a complete list of patents covering processes of manufacture of phosphoric acid and the various soluble or available phosphates. The patents are not merely listed, but are sufficiently abstracted to describe the general nature of the processes and the reagents used. This book of 370 pages contains a wealth of information on a very interesting subject. Oliver Bowles.

Engineering Problems Manual. By Forest C. Dana and Elmer H. Wilmarth. The McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York. Price $2.

The authors are both members of the faculty of Iowa State College. They state in the preface that their book is not a textbook on mathematics, physics, or elementary mechanics, but rather a student's notebook covering the work offered in the engineering problems course at the Iowa State College. The book has been prepared for use in the courses given at the State College. Enough tabulated material has been included to give information necessary in solving the practice problems. The book sets forth an efficient and effective method for obtaining neat, legible, well-organized calculation sheets. The problems are taken from typical engineering situations and are largely in skeleton form, so that users of the book may utilize figures and data obtained from their own practical experience.

PATENTS

Process of Roasting. No. 1,644,692. Oct. 11, 1927. John Burns Read, Golden, and Melville F. Coolbaugh, Denver, assignors to the Complex Ores Recoveries Co., Denver, Colo.

A method of roasting sulphides. The sulphides are fed into and through a furnace and the air for oxidation is introduced at a point in advance of that at which the sulphides enter. One portion of the hot gases is caused to travel against the ore stream while the remainder are caused to travel concurrently with the ore. The portion of the gases which travels in counter current to the ore stream is used to heat the sulphides as they are introduced into the furnace.

Pulp Thickener. No. 1,644,854. Oct. 11, 1927. Edwin Letts Oliver, assignor to Oliver Continuous Filter Co., Oakland, Calif.

A new design for a filter.

Replaceable Liner for Reverberatory Furnaces. No. 1,645,011. Oct. 11, 1927. Briggs R. Kinney, Miami, Ariz.

Design for a furnace in which the lining is removable.

Hydraulic Conveyor. No. 1,644,699. Oct. 11, 1927. Frederic L. Ward, Detroit, Mich.

A hydraulic conveying system for sand, gravel or such material.

Electric Furnace. No. 1,645,091. Oct. 11, 1927. Verni J. Chapman, Schenectady, N. Y., assignor to the General Electric Co.

Design for an electric crucible furnace.

Electric Furnace. No. 1,645,119. Oct. 11, 1927. Christian Steenstrup, assignor to General Electric Co., Schenectady, New York.

Design for an electric furnace in which the smelting operation may be conducted in the presence of a selected gas.

Mineral Machine. No. 1,645,378. Oct. 11, 1927. John Brown Fender, Kaufman, Texas.

Design for an agitating tank embodying feeding hoppers and auxiliary tanks.

Waterproof Cap and Fuse. No. 1,645,379. Oct. 11, 1927. Joseph P. Fletcher, Prescott, and Orin S. Culver, Blue Bell Siding, Ariz.

A waterproof cap and fuse, the waterproofing being effected by a closely adhering coating of rubber cement.

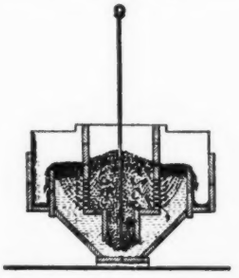
Chromium Plating. No. 1,645,927. Oct. 18, 1927. Harrie C. Pierce, assignor to Metals Protection Corporation, Indianapolis.

The process uses an electrolyte of chromic acid, and the current is passed first through the article as an anode and is then reversed to pass from the pole which was previously used as a cathode, to the article to be plated.

Process of Making Sponge Iron From Its Oxide Ores. No. 1,645,968. Oct. 18, 1927. William Wallace Percy, assignor of one-fourth to Frank W. Harris, Renton, Wash.

The iron ore is allowed to fall through a column, and during its passage is subjected to the reducing action of the gases derived from the combustion of hydrocarbon fuel introduced into the column.

Flotation Method and Apparatus. No. 1,646,019. Oct. 18, 1927. David Lawton Forrester, Globe, Ariz.



The pulp is aërated by discharging air in large bubbles into it at a substantial depth below its surface. Currents of pulp are directed against the bubbles near their point of entry and the pulp is caused to circulate through zones, one of violent agitation and the other of approximate quiesence. These zones are isolated from each other and the mineral-bearing froth is removed from the zone of quiesence.

Ore-Sampling Machine. No. 1,646,032. Oct. 18, 1927. Seward Mason, Helena, Mont.

Design for a sampler approximately of the Vezin type.

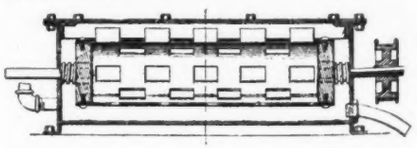
Loading System. No. 1,646,197. Oct. 18, 1927. Robert P. Greenleaf, assignor to Frank Billings, Cleveland, Ohio.

Design for a system of operating scrapers to load cars under ground.

Manufacture of Ferrophosphorus. No. 1,646,268. Oct. 18, 1927. Joseph Warner, Nashville, Tenn.

Process for the production of high-grade ferrophosphorus by charging into a furnace a mixture containing ferrophosphorus coke, phosphate-bearing material, and a metallic substance, the amount of phosphate-bearing material added being in only such quantity as to provide the necessary flux to combine with the silicate in the mixture.

Flotation Machine. No. 1,646,351. Oct. 18, 1927. Fred De Mier, Picher, Okla. Assignor to William A. Butchart, Joplin, Mo.



A flotation machine of the kind indicated by the illustration.

Personal Notes

H. C. DUDLEY was recently at El Paso, Tex.

P. G. BECKETT, vice-president of the Phelps Dodge Corporation, has returned to Douglas, Ariz.

Colonel WILLIAM BOYCE THOMPSON has left New York for his winter residence at Superior, Ariz.

H. E. DOELLE has returned to New York after a reconnaissance trip in various mining regions in South America.

JOHN MARTIN has joined the administrators of the Central Mining & Northwest Corporation, Ltd., at Johannesburg.

T. A. RICKARD, who is president of the English Speaking Union in California, attended the annual convention of that organization at Chicago on Oct. 28.

Prof. J. S. DE LURY, of the University of Manitoba, instructor in geology at Saskatchewan University, recently made a survey of Saskatchewan's mineral wealth.

L. J. MOORE, financial editor of the *Toronto Globe*, has resigned his position and has purchased a seat on the Standard Stock and Mining Exchange and will open a brokerage office.

R. DENING has been appointed consulting engineer of the Vipond, operating in the Porcupine area of northern Ontario, in succession to J. MACKINTOSH BELL, who recently resigned the position.

STANLY A. EASTON, vice-president and general manager of Bunker Hill & Sullivan, recently visited scenes of Bunker Hill activity in the Deadwood and Yellow Pine districts of south central Idaho.

Sir EDGEWORTH DAVID, late professor of geology in the Sydney University, who has been in England for some time, was expected to return to Australia in October, as he was scheduled to leave London on Sept. 24.

W. W. WISHON, president of the Wishon Exploration Co., the main Western office of which is at Kingman, Ariz., has moved his headquarters to a branch office at Room 244 Douglas Building, Los Angeles.

JOHN D. GROTHE, technical director of the Société-Dorr et Cie of Paris, arrived in New York on Oct. 18. He will spend several months studying the progress made in engineering since his last visit to this country five years ago.

CHARLES HAYDEN, of Hayden, Stone & Co., and DANIEL C. JACKLING, president of the Utah Copper Co., are sailing for a pleasure trip around the world, starting from California. They are expected to be abroad several months.

E. C. ANDREWS, prominent Australian geologist, is visiting in the United States after touring Canada with the Empire Mining Congress. He is now in New York, but will do considerable traveling before sailing for home, about the first of the year.

W. C. PAGE, formerly with the International Smelting Co., at Tooele, Utah, is now temporarily with the Roan Antelope Copper Mines, Ltd., at N'Dola, Northern Rhodesia, South Africa, in connection with concentration work on the development of that property.

ROBERT A. ELGIN is engaged in experimental work on stope blasting at the United Verde at Jerome, Ariz. His article "A Simplified Solution of Ventilation Problems of Hot Mines," published in the Oct. 1 issue, was a part of his thesis for the degree of mining engineer at Stanford University.

ROBERT A. ELGIN

DR. LUDLOW J. WEEKS, of the Canadian Geological Survey, Department of Mines, and an assistant, MAURICE H. HAYCOCK, of Wolfville, Nova Scotia, accompanied the 1926 Canadian Arctic expedition as far as Baffin Island and returned on this year's patrol ship.

ARTHUR A. COLE writes to us to point out that the title of the article which appeared in our issue of Oct. 8, "Canadian Government Operates Sampling Mill," is misleading. As was mentioned in the text, the plant is operated by the government of Ontario and not by the Dominion government.

OBITUARY

OSCAR JONES, a U. S. Geological Survey employee since 1895, died on Oct. 21 in Washington. He was first appointed field assistant in the Geological Survey on May 1, 1895.

EDWARD J. FOWLER, foundry metallurgist and president and general manager of the Pacific Foundry Co., died recently in San Francisco. He was about fifty-five years old.

STEPHEN HERBERT GREENWOOD, familiarly known as "Bert," for many years manager of the hardware department of the Anaconda Copper Mining Co., at Butte, and well known in mining circles throughout the Northwest, died on Oct. 15.

BERNARD ADDINGTON RIVETT, a grandson of late Lord Addington of Derby, England, who served as lieutenant in the British Navy during the war, died in Winnipeg on Oct. 19 as a result of a fall from his horse. He came to Canada last spring, and engaged in prospecting in the Woman Lake area of Patricia district, assuming the name of Peter Jackson to avoid publicity, and was interested in the Manion Jackson property. Mr. Rivett was preparing to return to England when the accident occurred.

Captain SAMUEL B. HARRIS, of Hancock, Mich., oldest mining man in the Michigan copper district, died on Oct. 18 at the age of ninety-three. He was born in Cornwall, England, in 1834, and came to the United States when nineteen years of age. He was closely associated with the early mining development of the district. His first work was in the lead mines of Wisconsin, and he came to the Michigan copper country in 1856. He was with various companies in Ontonagon, Keweenaw, and Houghton counties during his long and active career. In 1882 Harris became superintendent of the Quincy Mining Co., and he remained in that position until 1904, when he resigned and retired from active business life.

D. BRUCE SMITH died recently in Los Angeles. Mr. Smith was associated with H. C. Dudley and the latter's associates in different mining ventures. He discovered the Ahumada and was superintendent of this property during its period of development and payment of early dividends. Last fall, as a result of a careful study and the elimination of limestone islands in the desert as possible ore-bearing ranges, he discovered the Perdido mine, in the Garibaldi Range, 12 miles from Ahumada. He had taken charge of the Ventura mine for H. C. Dudley when taken sick, and failure to respond to treatment resulted in his death. He was highly regarded by the mining fraternity in the Southwest.

CHARLES R. ANGUISOLA, pioneer civil and mining engineer of the Southwest, died on Oct. 16 in a hospital in Phoenix, Ariz. Mr. Anguisola was a Californian of Spanish descent. At the age of eighteen he graduated from Santa Clara College, in California, and at twenty-one was assistant chief engineer for the United Verde Copper Co. From Jerome, Mr. Anguisola went to Cananea, Mexico, and was instrumental in purchasing the famous Chivetera mine of the Cananea Consolidated Copper Co. from a Mexican goat herder for the reported sum of $250. For the last seven years Mr. Anguisola had been a consulting engineer, making Phoenix, Ariz., his headquarters, but spending most of his time in Old Mexico. He was fifty-four years old.

MARKET AND FINANCIAL NEWS

German Metal Business Expanding

By Dr. James Rubinfeld
Berlin

CONSUMPTION of crude metal in Germany continues to increase. In many lines there should be an increase this year of 100 per cent, and in others at least 80 per cent above last year's figures. This must be ascribed to the buoyancy of the brass market, to good cable orders, and to long overdue filling up of other needs. The following table speaks for itself:

German Metal Imports in Metric Tons
January-August

	1927	1926
Copper	148,901	87,595
Lead	102,150	52,258
Zinc	96,488.8	59,813
Tin	10,045	5,786.8
Nickel	2,275	932.7
Aluminum	6,828.8	3,232
Antimony	2,358.5	1,402.5

Imports of silver were 272,639 kg., as compared with 154,498 kg., and imports of ferro-alloys have been roughly from five to six times the amount of those in the preceding year. Germany is now the outstanding buyer of American copper, for of course the 6,000 tons of that metal which the official statistics denote as coming from Chile in August are under control of United States concerns. On the other hand, Great Britain imported only around 6,000 tons from the United States in August. Thus the import of 16,000 tons in August from the United States alone exceeds by 3,000 tons the whole imports of August, 1926. Should the German demands for copper continue in this way, her copper consumption will very soon equal, if not surpass, the rate of pre-war times, in spite of the diminution of Germany's territory by a tenth as a sequel to Versailles. Now there are many possibilities of a further increase; for instance the Federal Railways are about to give orders amounting to 100 millions of reichsmarks; then there are plenty of reparation orders to execute in France, and the Balkans in addition to many electrification projects here and abroad. It is small wonder that people here congratulate themselves upon the moderate price policy of the Brussels Copper Exporters, Inc., who are adhering to their program of stabilizing copper prices, the more so as the level of living costs in Germany is mounting again as a consequence of dear money and higher wages. On the other hand, however, as far as export business is concerned, complaints are often heard about the advantage to American copper manufacturers owing to the difference of the c.i.f. Hamburg, Bremen, or Rotterdam price and the delivered Connecticut Valley price. As a matter of fact, undercutting Brussels quotations has been restricted to negligible fractions of the entire demand on the bourses, but it is a sign of the times that option copper business on the metal exchanges of Berlin and Hamburg is heavily decreasing, as the stabilizing policy of the Cartel stands in the way of speculation, and moreover diminishes the legitimate needs of users for long covering operations. This fact must be stressed, because on the German exchanges option dealings spread over twelve months instead of three months, as on the London Exchange.

The reverse is the condition with lead. Control is lacking and speculation is already customary in Europe. News coming along from time to time that the American sellers have here and there made concessions to consumers in spite of so-called official quotations of the *Engineering and Mining Journal*, or some arrivals from Australia to the Hamburg free port, have a decidedly weakening effect in a glutted market, but I doubt whether there exists at the moment an oversupply of lead, as the hand-to-mouth buying has become universal in this field, too. As a matter of fact, even on the Berlin Metal Exchange offerings in lead are not so heavy as might be imagined from latest price movements; and London has to stand the whole brunt of hedging and bear operations. Although the building season will soon end, there should be some good buying of lead toward the end of the year for pending orders.

With regard to tin, the German tin-plate industry has made further rapid strides since my last letter, whereas the Welsh business is going from bad to worse. Though German tin-plate output in 1913 reached about 65,000 tons, the time is not far distant when it will be double this figure, although the increase dates only from the beginning of the British coal strike. The happy feature of this trade is the concentration of 90 per cent of sales in the hands of one single concern, the Otto Wolff company of Düsseldorf. The so-called rationalizing of production methods is also helping this industry. Russian tin, as also lead and zinc buying, which has been transferred to Hamburg from London, since the Arcos affair, is of some help to the tin trade of this country. People here are interested in the aims of American tin-plate manufacturers to reduce the contents of tin in making tin plate, and babbitt metal is once more favored here when it is a tin alloy. Tin foil has become an entirely unknown commodity in Germany since the aluminum foil was placed on the market.

It has been rumored that the Aluminum Company of America has purchased a goodly share of the Bauxit Trust A. G., of Zurich, and some comments have been evoked; but I am informed authoritatively that no interest has been taken by the leading American interests, the representative of which has sent a denial to the German press. Meanwhile, aluminum consumption here has taken an upturn consequent upon the enlivening of the automobile, the airplane, and the radio industries, which has been a feature of last year.

Although there are constant rumors about the World Zinc Cartel to be negotiated ere long under participation of the Anaconda, I am informed on good authority that such negotiations have not taken place for several months. As a matter of fact, much, if not everything, depends on the attitude of the Americans and not on that of the Anaconda alone. But in German circles there is a readiness to believe that in view of the weakening of zinc and the steady increase of output the time may not be far off when the Americans may incline to conclude something akin to a "Brussels pact." At this moment there is some oversupply of zinc metal in Germany, and prices are bound to fall further.

The Monel-Metallgesellschaft of Frankfort-on-Main (a subsidiary company of the International Nickel Co.) has made good progress in introducing the alloy in Germany. The "peaceful war" the German steelmakers are now waging on one another to create "stainless" or other quality steels helps to increase consumption of nickel and chrome.

Important Cable Companies Merge Interests

AGREEMENTS have been concluded for the combination into a newly organized company to be known as the General Cable Corporation of the business plants and assets of the Dudlo Manufacturing Co., the Rome Wire Co., the Safety Cable Co., the Standard Underground Cable Co., and the sheet-, rod-, and wire-rolling mills of the Baltimore Copper Smelting & Rolling Co. The new organization will represent interests amounting to $50,000,000 and will have as chairman Joseph

W. Marsh, president of the Standard Underground Cable Co. The company will be able to supply customers with every kind of copper wire from the classes used in the construction of delicate instruments to the heaviest underground cables. Tubing, sheets and rods are also listed among its products. It will have the advantage of numerous warehouses situated at important centers, so that not only will the whole process of manufacture be placed on a more efficient and economical basis but the distribution of products to consumers will be facilitated. Another important aspect of this merger is the increased opportunities and facilities which it will offer in respect of research work. The capitalization will consist of $16,000,000 first-mortgage 5 per cent bonds, $15,000,000 par value 7 per cent preferred stock, and approximately 400,000 shares of Class A stock, with 440,000 shares of common stock. It is understood that Dillon Read & Co. and Kissel Kinnicutt & Co. are behind the merger.

Mining Company Dividends Total Suffers From Absentees

ABSENCE of the name of the Consolidated Mining & Smelting Co., of Canada, with its disbursement of $3,170,975, was the main factor in bringing down the total of dividends paid by mining companies in October compared with July, the corresponding month of the preceding quarter. The Consolidated pays semi-annually, and accordingly is not to be expected among those in the October list. Arizona Commercial, Virginia Iron & Coke, and Mining Corporation of Canada are in the same category; that is, semi-annual payers in January and July.

New Jersey Zinc's July dividend was an extra. Two companies, Granby and Portland Gold, have passed the quarterly dividends that were due in October. Granby paid its first dividend since 1919 in July, but apparently it was thought prudent not to strain resources by continuing payments.

Glancing back at the table of dividends for October, 1926, one finds that quite a number of dividend payers at that time have dropped from the list for the time being. These include Inspiration, Utah Apex, Gladstone Mountain, Consolidated Lead & Zinc, Ahumada Lead, Belmont, Surf Inlet, Silversmith, Kerr Lake, and Whitewater. Wright-Hargreaves was in the October group a year ago and is not represented this month; this, however, is not significant, for the reason that the payment will be made on Nov. 1.

On the other side of the ledger are to be found some new companies. The Success Mining Co., operating in the Coeur d'Alene district, in Idaho, paid a dividend for the first time in several years, and incidentally the last, for the company presumably is to be dissolved. Isle Royale and Tonopah Mining Co., of Nevada, are semi-annual payers that were not in the list of July.

Colonel Ayers Views New Ford as Potent Influence

In the current *Business Bulletin* of the Cleveland Trust Co., Colonel Leonard Ayers declares his belief that the completion of the design of the new Ford automobile was the most important business development of the last month, although it has not been reflected in the current statistics of industry or trade. It is destined, nevertheless, to play a most influential part in shaping the course of business activity during the coming months, and next year.

In future years, says Colonel Ayers, when the business history of 1927 is studied in retrospect, it will probably be the verdict of careful students of such matters that the general slowing down of business which has characterized the second and third quarters of this year was caused in no small measure by the shutting down of the great Ford plants. We are perhaps accustomed to thinking of matters relating to that particular automobile company as being comparable to similar developments in the affairs of the other leading manufacturers in the same field, and perhaps even as lacking something of the same general interest because the Ford shares are not dealt in on the stock exchanges.

Colonel Ayers says that "Such an attitude is far from being justified. The fact is that in terms of productive capacity the Ford company comes close to being half of the automobile industry of the entire world. Its activities include the operation of railroads and fleets of vessels, extensive mining of coal and iron ore, lumbering, manufacturing of glass and textiles, and other varied industrial undertakings on a great scale.

Last May it was announced that when it had completed the manufacture of fifteen millions of its Model T machines the plants would be closed down, and a new model developed.

"The new models have now been completed, and some hundreds of thousands of orders for them have already been placed, and are waiting to be filled. Manufacturing industry throughout the Middle West will soon feel the stimulus of this new business, while railroad traffic, and wholesale and retail trade will be affected by it throughout the country."

Mining Dividends and Yields for October, 1927

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
Aluminum Co. of America, pfd	Various	$1.50 Q	$1,104,570	5.8
Bingham Mines, s,l	Utah	1.00 Q	50,000	8.6
Bunker Hill & Sullivan, l,s	Idaho	0.75 M	245,250	6.7
Cleveland-Cliffs Iron	Mich.	1.00 Q	400,000	5.1
Cresson Consolidated Gold	Colo.	0.10 Q	122,000	20.0
Eagle-Picher Lead, pfd., l,z	Okla., Mo.	1.50 Q	12,769	5.1
Homestake Mining, g	S. D.	0.50 M	376,740	j9.0
Inland Steel, pfd	Minn.	1.75 Q	175,000	6.2
Isle Royale Copper Co	Mich.	0.50 I	75,000	....
Kennecott Copper	Alaska	1.25 Q	5,620,754	8.0
Magma Copper, c,s	Ariz.	0.75 Q	306,116	6.6
Newmont Mining, h	Various	1.00 Q	452,760	4.1
Nichols Copper, pfd	N. Y.	1.75 Q	40,173	....
Park Utah Consolidated, s,l,z	Utah	0.20 Q	418,700	11.4
Phelps Dodge, c	Various	1.50 Q	750,000	5.0
Republic Iron & Steel, pfd	Various	1.75 Q	437,500	6.7
Silver King Coalition, s,l	Utah	0.25 Q	304,025	11.1
Sloss Sheffield Steel & Iron, pfd	Ala.	1.75 Q	117,250	6.5
Success Mining Co	Idaho	0.0125 I	18,750	....
Tonopah Mining Co	Nev.	0.075 S.A.	75,000	7.5
U. S. Smelting, Refining & Mining, s,l	Various	0.875 Q	307,226	11.0
U. S. Smelting, Refining & Mining, pfd	Various	0.875 Q	425,556	7.0
Companies in other countries:				
Asbestos Corporation, pfd	Quebec	1.75 Q	130,482	6.2
Dome Mines, g	Ont.	0.25 Q	238,333	10.0
Erupcion, l,s	Chihuahua	0.075 Q	93,750	10.8
Hollinger Consolidated Gold	Ont.	0.10 4 wks.	492,000	7.0
Howe Sound, s,c,l	B. C., Mex.	1.00 Q	496,038	10.1
Lucky Tiger-Combination, g,s	Sonora	0.05 M	35,767	9.0
New York & Honduras Rosario, g,s	Honduras	0.50 QX	100,000	....
Nipissing, s	Ont.	0.075 Q	90,000	4.6
Premier Gold, s,g	B. C.	0.08 Q	400,000	14.2
Total			$13,910,750	

s, silver; l, lead; z, zinc; g, gold; c, copper; h, holding; Q, quarterly; M, monthly; X, extra; QX, $0.25 regular and $0.25 extra; SA, semi-annually; I, irregular; j, based on dividends for the last twelve months.

STATISTICAL NOTES

MCINTYRE-PORCUPINE MINES, LTD., report net earnings of $453,836 for the second quarter of the year. This brings the net earnings for the first half of 1927 up to $829,979, which is $21,492 less than during the same period last year. The following is a summary:

	Second Quarter Sept. 30, 1927	Total for Six Months
Gross recovery	$981,251	$1,875,418
Costs including development	532,885	1,055,527
Operating earnings	$448,366	$819,891
Non-operating revenue	27,497	48,466
	$475,863	$868,358
Less provision for taxes	22,027	38,379
Net earnings before depreciation	$453,836	$829,979

SAN FRANCISCO MINES OF MEXICO, LTD., reports operations for September as follows: Ore treated, 23,620 tons; lead concentrates produced, 3,100 tons; zinc concentrates produced, 3,728 tons. Estimated net smelter return on lead concentrates, $175,869 and on zinc concentrates, $91,682; total, $267,551. Operating expenses were $133,999, and estimated operating profit was $133,552.

The Market Report

Quiet Week in Metal Markets With Prices Tending to Ease

New York, Oct. 26, 1927—The extreme activity in buying of copper and lead apparently ran its course last week, and the week ending today has been a quiet one in the non-ferrous metal markets. Buying of copper has been particularly dull, whereas there was a little more activity in zinc than in the preceding week. Prices have tended toward lower levels, zinc suffering particularly in this respect. The Aluminum Company of America last Thursday reduced its price on various grades by 1c. per lb. and prices for antimony are easier.

Daily Prices of Metals

Oct.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
20	12 95	57 375	58 375	6 25	6.00@6.05	6 00
21	12 90	58 00	58 75	6.25	6 00	5 975
22	12 925	58 00	58.75	6.25	6.00	5 95@6.00
24	12 90@12 975	58 125	59 00	6 25	6.00	5.925@6.00
25	12 90@12 975	57 75	58 50	6 25	6.00	5.90
26	12 90@12 975	58.00	58.625	6.25	6.00	5.90
	12 931	57 875	58 667	6.250	6 004	5 952

Average prices for calendar week ending Oct. 22, 1927, are: Copper, 12.973; 99 per cent tin, 57.563; Straits, 58.521; N. Y. lead, 6.254; St. Louis lead, 6.031; zinc, 6.002; and silver, 56.313.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Oct.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
20	55 1/2	55 9/16	62 1/2	264 1/4	260 7/8	20 5/8	20 5/16	27 1/16	26 13/16
21	55 1/2	55 1/2	62 1/2	265 1/2	262 1/4	20 5/16	20 3/4	26 15/16	26 11/16
24	55 11/16	55 11/16	62 1/2	267 1/4	263 3/4	20 1/8	20 1/2	26 7/8	26 5/8
25	56	55 15/16	62 5/8	265 3/4	261 3/4	20 1/8	20 9/16	26 5/8	26 5/8
26	56 7/16	56 7/16	62 5/8	266 3/4	262 3/4	20 1/2	20 7/8	26 3/4	26 7/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Oct.	Sterling Exchange "Checks"	Silver		Gold London	Oct.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
20	4.86 3/4	56 1/4	25 11/16	84s11 d	24	4.86 11/16	56 1/4	25 13/16	84s11 1/4 d
21	4.86 3/4	56 1/8	25 3/4	84s11 1/4 d	25	4.86 3/8	56 1/8	25 3/4	84s10 1/2 d
22	4.86 3/4	56 3/8	25 7/8	.....	26	4.86 9/16	56 1/4	25 13/16	84s11d
					Avg.		56.229		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Copper Very Dull

The copper market has again relapsed into a condition of stagnation such as existed prior to the wave of buying that took place last week. As before, the leading producers are almost uniformly holding at 13.25c., at which level only scattering sales have been made, and these for small tonnages. Two small sales were made in the Middle West at 13.375c. Connecticut Valley business was done at 13.125 and 13.25c. and at various odd figures between. Export sales have been made in reasonable volume at the association price of 13.60c. c.i.f. and at 13.35c. f.a.s. The consummation of plans for the organization of the General Cable Corporation as a consolidation of important copper-wire consumers manufacturing something less than half of the cable made in the United States is not likely to have any immediate effect on the copper market, according to the opinion of competent observers, though buying will naturally be centralized to a much greater extent than heretofore.

Lead Market Quieter

The continued weakening in the London lead market, which culminated yesterday in a spot quotation of only £20 2s. 6d., put a quietus on buying in the United States, consumers evidently thinking that a reduction in prices was in order. Middle Western producers did go back to 6c., St. Louis, but the American Smelting & Refining Co. continued its contract price in New York at 6¼c., though only an occasional carload was sold in the East on that basis outside of contract requirements. Lead might have been obtained at concessions of as much as 10 points from that quotation in the last two or three days, from at least one seller, if any one had shown an interest in buying a good lot. Today, some encouragement was felt in the advance reported from London, and from a good foreign demand that has been stimulated by the lower prices.

Though producers in the Middle West have refused to go below 6c., St. Louis, a parcel of second-hand lead for prompt shipment has been looking for a buyer, bids of 5.95c. being invited. There is little demand for anything but prompt shipment. Consumers report white lead business good, lead oxide improving, and mixed-metal business somewhat disappointing. Production statistics that appeared during the week were disappointing in not showing more of a curtailment, but it is probable that production and consumption are fairly well balanced at current rates.

Zinc Declines to 5.90c.

A moderate business in zinc was done during the week, but at gradually declining prices. For some months the approach to a 6c. level has always been followed by some improvement, but the market has finally broken through, and is established for the time being at 5.90c. The semi-monthly report of the American Zinc Institute shows an in-

crease of stocks between Oct. 1 and Oct. 15 from 34,277 to 36,681; likewise the report of the A.B.M.S. showed that the world production in September was a shade higher than in August. These figures naturally tended to operate in favor of the buyers. Producers of High-Grade zinc quote 7.75c., New York, as against 8c., which they have held for several months. However, the spot price is purely nominal.

Little Change in Tin

A fair demand for tin for prompt shipment to consumers manifested itself during the week, but in general the market has been rather quiet at prices varying between 58 and 59c. per pound for prompt Straits. Futures have been approximately half a cent less than prompt.

Silver Holds Gains

The silver market has continued steady during the week, fluctuating between 56⅛ and 56⅜c. Buying for China account has been the chief support of the market, as orders received from India were at rates under New York quotations. The market closes quiet and steady.

Mexican Dollars (Old Mexican pesos): Oct. 20th, 42⅞c.; 21st, 42⅝c.; 22d, 43c.; 24th, 42⅞c.; 25th, 42¾c.; 26th, 42⅞c.

Foreign Exchange

Closing cable quotations on Tuesday, Oct. 25, were as follows: francs, 3.925c.; lire, 5.465c.; and marks, 23.87¼c. Canadian dollars, 9/64 per cent premium.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 98 or 99 per cent grade, price of leading interest, 25c.; outside market, nominal, no business by independents since the leading interest announced a cut of 1c. per lb. on Oct. 20.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week, 11¼@11c. Quiet. Cookson's "C" grade, spot, 17¾c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

BISMUTH—Per lb., New York, in ton lots, $1.85@$2.10. London, 8s.

IRIDIUM—Per oz., $105@$108 for 98 @99 per cent sponge and powder. Market dull.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade) for single lots of spot metal.

PALLADIUM—Per oz., $52.50@$53.50. Small lots bring up to $56. Market very dull and prices easy.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $72. Dealers and refiners quote the trade for refined metal, per oz., cash, $64@$65. Market moderately active.

QUICKSILVER—Per 76-lb. flask, range for week $126@128, depending on quantity. San Francisco wires $126.67. London, £22½@£23.

RHODIUM—Per oz., $50@$52; London £8@£11½, nominal.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Oct. 8.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn. 36@38c. Caucasian, washed, 53@55 per cent, 40c. Chemical grades unchanged from quotations in the Oct. 8 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.10@$10.35. Western scheelite, $10.35@$10.60. Market dull.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the Oct. 8 issue.

Joplin Ore Prices Unchanged

Joplin, Mo., Oct. 22, 1927

Blende		Per Ton
High		$42.20
Premium blende, basis 60 per cent zinc	$39.00@	40.00
Prime Western, basis 60 per cent zinc		38.00
Fines and slimes, 60 per cent zinc	35.00@	37.00
Average settling price, all zinc		38.89
Galena		
High		$82.90
Basis 80 per cent lead		80.00
Average settling price, all lead		81.49

Shipment for the week: Blende, 19,271; lead, 1,427 tons. Value, all ores the week, $865,890.

Since the American Metal Co. returned to the market, and began the purchase of flotation concentrates, other smelters have increased their demand for this product. Producers have long been urged to refrain from mixing the flotation production with the jig concentrates. Demand was spirited today for all grades, especially the flotation output, but sellers were slow to market on the current price, and only 13,500 tons was obtained. The zinc ore shipment this week has been larger than in any other week this year. Smelters are taking up stocks in the bins of producers purchased several weeks ago. The lead ore market is quiet and desultory.

Platteville, Wis., Oct. 22, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$40.75
Lead Ore	
Lead, basis 80 per cent lead	$80.00

Shipments for the week: Blende, 1,141 tons; lead, none. Shipment for the year: Blende, 53,719; lead, 1,485 tons. Shipment for the week to separating plants 1,887 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Oct. 8 issue.

Mineral Products

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market slack. London, Cornish white, per long ton, £18@£18¼.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Oct. 8 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, 78@82 per cent, $90, f.o.b. furnace, for delivery during second half 1927. Spiegeleisen, 19@21 per cent, $30@$31 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 93@96c. f.o.b. works. Dull.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Oct. 8 issue.

Metal Products

ROLLED COPPER—Per lb., f.o.b. mill, sheets, 22c.; wire, 15¼c.

LEAD SHEETS—Full rolled 9½c.; clipped 10c. per lb.

Nickel Silver, Yellow Metal, and Zinc Sheets unchanged from prices in Oct. 8 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the Oct. 8 issue.

Steel Buying Continues Dull

Pittsburgh, Oct. 25, 1927

Steel demand, in new orders and in specifications against contracts, has been scarcely as heavy thus far this month as in the same period of September, and the prospect is that there will be a further decrease, as demand in some lines will fall off seasonally. Some freight-car buying is possible.

Steel prices are not holding well, although there are no outright declines from week to week. The minimum of 1.75c., Pittsburgh, on bars, shapes, and plates has been holding, but efforts to obtain 1.80c. or 1.85c. on small lots are practically abandoned, even in bars. Early in the month sheet prices declined $2 a ton, and now blue annealed and galvanized sheets are being shaded $1 to $2 a ton by several mills.

Pig Iron—The Valley market continues dull, with prices unchanged at $18 for bessemer, $17 for basic, and $17.50 for foundry, f.o.b. Valley furnaces.

Connellsville Coke—Spot demand is almost wholly lacking and production is at the lowest rate for a long time. Spot: Heating, $2.65@$2.75; furnace, $2.85@$3; foundry, $4@$4.75.

Current Prices of Mining Supplies

Rise and Fall of the Market

THERE were twice as many declines as advances, during the last thirty days, in prices of mining supplies. A firmer market prevails everywhere, in mine timbers, owing to increasing scarcity of this material. Lime prices appear stronger. Leather belting and manila rope quotations are slightly above September levels. The principal declines of the month occurred in steel sheets, railroad spikes, fish plates, structural shapes, cast-iron pipe, wire nails, linseed oil, and litharge.

SHEETS—Quotations are per 100 lb. in various cities from warehouse, also the base quotations from mill:

	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
Galvanized No 24	$3.85	$5.25	$4.80	$5.35	$4.95

STEEL RAILS—The following quotations are per gross ton f.o.b. Pittsburgh, Chicago and Birmingham for carload or larger lots:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Current	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80	$2.80–$2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.90–4.25	3.90@4.25	4.55	4.60	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.85@2.95	3.40	3.75	4.25	2.95

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. mill, Pittsburgh and Birmingham. At other cities listed, quotations apply on less-than-carload lots, from warehouses.:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.75@1.80	$2.05	$3.34	$4.00	$3.25	$3.10	$3.00
Channel, 3 to 15 in.	1.75@1.80	2.05	3.34	4.00	3.25	3.10	3.00
Angles, 3 to 6 in., ¼ in. thick	1.75@1.80	2.05	3.34	4.00	3.25	3.10	3.00
Tees, 3 in. and larger	1.75@1.89	2.05	3.34	4.00	3.35	3.10	3.00
Plates ¼-inch thick	1.75@1.80	1.95	3.34	4.00	3.25	3.10	3.00

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Galvanized iron rigging and guy rope	12½%

	New York	Cleveland	Chicago
DRILL ROD (from list)	60%	55%	50%

WROUGHT IRON AND STEEL PIPE—The following discounts from list, are to jobbers for carload lots at Pittsburgh mill:

	Steel			Iron		
	Inches	Black	Galv.	Inches	Black	Galv.
BUTT WELD—	⅛ to 3	62	50½	⅛ to 1¼	30	13
LAP WELD—	2½ to 6	59	47½	3 to 6	28	13

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
2½ to 6 in., lap welded	48%	51%	46%

CAST-IRON PIPE—The following are prices on class B, per net ton, for carload lots:

	New York					
	Current	One Year Ago	Birmingham	Chicago	St Louis	San Francisco
6 in. and over	$40.60	$51.60@52.60	$28.00	$36.20	$33.60	$39.00

NUTS—Hot pressed or cold punched, square or hexagonal, blank or tapped, up to 1-in., inclusive, full kegs or cases, discount 55% from new list, April 1, 927, at warehouses in New York and vicinity.

HOLLOW TILE—Price per block in carload lots, f.o.b., to contractors, for hollow building and partition tile.

	New York						Perth Amboy N. J., Factory
	Current on Trucks‡	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco‡	
4x12x12	$0.1027	$0.1027	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1541	.1541	.104	.....	.09	.156	$0.2388*
8x12x12	.1926	.1926	142	.21	.126	.244	.2956†

* 10x12x12; † 12x12x12. ‡ Partition tile.

MACHINE BOLTS—Square heads and nuts, up to 1x30-in., full kegs or cases discount 50% from new list, April 1, 1927 at warehouses in New York and vicinity.

LUMBER—Prices wholesale, per M ft. b.m., in carload lots, f.o.b. **San Francisco**—At yards, rough Douglas fir, No. 1 common:

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers alongside dock. Price to contractors, delivered to job, is $5@$10 additional:

	New York		Chicago	
	20 Ft. and Under	22-24 Ft.	Up to 20 Ft., Pine	Up to 32 Ft., Fir*
3x4 to 8x8	$43.00@46.00	$44.00@47.00	$38.00	$39.50
3x10 to 10x10	50.00@53.00	51.00@54.00	45.00	39.50
3x12 to 12x12	57.00@60.40	58.00@61.00	54.00	39.50

Other Cities—Prices are for rough timbers:

	8 x8-In. x 20 Ft. and Under				12 x 12-In.‡ 20 Ft. and Under	
	Pine	Fir*	Hemlock Spruce		Pine	Fir*
Boston	$47.75	$47.50†	$49.00	$52.00	$57.25	$57.00
Cincinnati	50.00	.....	.....	.....	65.00	.....
Denver	.....	33.25	34.25	34.25	.....	34.25
Minneapolis	42.50	36.75	34.00	.....	47.00	38.75
Kansas City, Mo.	39.00	39.75	.....	.....	53.00	39.75
Philadelphia	48.00	36.00	38.00	45.00	62.00	36.00

*Douglas fir. †Prime. ‡3x12 to 12x12 Chicago S4S.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.95	$3.25	$4.25	$2.83	$4.95
Cut	2.80	....	4.90	5.00	2.95	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without charge for bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.35	$2.35	$2.50@2.60
Chicago, f.o.b.	2.05	2.05	2.10
Cleveland, f.o.b.	2.24	2.24	2.29

LIME—Warehouse; New York quotes bbl. 280 lb. net; Chicago, 180 lb.:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$19.45	$12.10	$3.50	$2.35@$2.50
Chicago	20.00	18.00	....	1.50

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrel (5 bbl. lots)	$0.78½	$0.87	$0.79	$0.85

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	13.75	15.25	15.25	16.75
White	13.75	15.25	13.75	15.25

HOSE—Quotations at New York warehouses:

Fire Protection — 50-Ft. Lengths
Underwriters' 2½-in. coupled, single jacket (net) ..... $0.68 per ft.

Air—Best Grade

½-in., per ft. ..... 3 ply $0.34 4 ply $0.42

Steam—Discounts from List

First grade ..... 40% Second grade ..... 40–5% Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. for rubber transmission belting. Discounts from list are as follows:

Best grade ..... 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ½ in.	$0.95
Rubber sheet	.50
Rubber sheet, wire insertion	.80

MANILA ROPE—Per lb., ½-in. and larger, 1,200-ft. coils.

Atlanta	$0.27	New Orleans	$0.21
New York	.25	Seattle	.23
Chicago	.23½	San Francisco	.22½

EXPLOSIVES—Prices per pound for dynamite in small lots:

	Gelatin	
	40%	60%
New York	$0.265	$0.2875
Minneapolis	.1917	.2123
Denver	.2025	.2275
Seattle	.165	.19
Cincinnati	.22	.245
San Francisco	.1625	.1925

FLOTATION OIL—Pine tar, 50 gal. bbl., gross weight 500 lb., f.o.b. New York, carload lots, per gal. $0.35

CHEMICALS—Prices for round lots in New York market, per lb.:

Zinc dust, 550 lb. casks	$0.09@.10
Litharge, casks	.08½
Sodium cyanide, 220 lb. single case lots	.18@.22
Calcium carbide, in drums	.05@.06

Mining Stocks—Week Ended October 22, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	47⅜	46	46⅛	Oc.15, No.21 Q	0.75
Arcadian Consol.	Boston	*65	*65	*65		
Ariz. Com'l	Boston	5⅜	5½	5⅜	Jy. 18, Jy. 30	0.25
Calaveras	N. Y. Curb			1⅞		
Calumet & Arizona	New York	88⅛	82½	83½	Se. 9, Se. 26 Q	1.50
Calumet & Hecla	Boston	16⅞	16⅜	16½	Au. 31, Se.15 Q	0.50
Cerro de Pasco	New York	64	60½	62	Oc.13, No.1 Q	1.00
Chile Copper	New York	35⅛	33⅞	33⅞	Se. 2, Se. 30, Q	0.62½
Con. Coppermines	N. Y. Curb	3⅞	3	3⅜		
Copper Range	Boston	15⅜	14	14⅜	Ap.2, My.2, A	1.00
Crystal Copper	BostonCurb	*35	*31	*32		
East Butte	Boston	1⅜	1⅛	1¼	Dec., 1919	0.50
Granby Consol.	New York	34½	33⅜	33⅝	Jn.15 Jy. 1 Q	1.00
Greene Cananea	New York	83½	67½	80⅜	Nov., 1920	0.50
Howe Sound	New York	38⅜	37½	37½	Oc.1, Oc.15, Q	1.00
Inspiration Consol.	New York	20⅜	17⅛	18⅛	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb	1⅞	1⅛	1⅛		
Isle Royale	Boston	12	11⅛	11⅜	Se.30, Oc. 15, Q	0.50
Kennecott	New York	75	70⅛	71½	Se.22, Oc. 1, Q	1.25
Magma Copper	New York	47½	43⅜	46	Se.30,Oc.15 Q	0.75
Mason Valley	N. Y. Curb	*80	*78	*80		
Miami Copper	New York	15⅛	14⅞	15	No.1, No.15, Q	0.37½
Mohawk	Boston	47⅛	45	45½	Oc.31, De. 1 Q	2.00
Mother Lode Coal	New York	2	1⅜	1⅞	Jn.10, Jn.30	0.25
Nevada Consol.	New York	16⅛	15⅜	15⅜	Se. 16, Se. 30 Q	0.37½
New Cornelia	Boston	23⅛	21	23	No.4, No.21 Q	0.50
Noranda	N. Y. Curb	26⅛	25⅝	25⅝		
North Butte	Boston	*1	*75	*80	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1.12	*93	*99	Sept. 1926	0.03
Old Dominion	Boston	11	11	11	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb			118	Se.21, Oc.1 Q	1.50
Quincy	Boston	16½	14⅜	14⅜	March, 1920	1.00
Ray Consolidated	New York			15½	Ap.20, Ap. 30	0.25
St. Mary's Min. Ld.	Boston	26	24	24	Fe.10, Ma.10	2.00
Seneca Copper	New York	1	1	6		
Shattuck Denn	Boston Curb	6⅜	6¼	6¼		
Tenn. C. & C	New York	8⅞	8⅛	8⅛	Au.31,Se.15, Q	0.12½
United Verde Ex	N. Y. Curb	27	26⅜	26⅜	Oc.6, No.1 Q	0.75
Utah Copper	New York			130	Se. 16, Se. 30 Q	1.50
Utah Metal & T	Boston	*98	*90	*92	Dec., 1917	0.30
Walker Mining	Salt Lake	*47½	*47	*47		
NICKEL-COPPER						
Internat. Nickel	New York	68¾	65½	65⅝	Se. 16, Se. 30 Q	0.50
Internat. Nickel pfd.	New York	109	109	109	Oc. 13, No. 1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*15½	*15	*15	June, 1927	0.005
National Lead	New York	119	111	111	Se. 16, Se. 30 Q	1.25
National Lead pfd.	New York	112½	111	112½	De.2, De. 15 Q	1.75
St. Joseph Lead	New York	38⅛	37¼	37⅛	De.10,De.20,QX	0.75
ZINC						
Am. Z. L. & S.	New York	6¼	6⅛	6⅛	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	40	36½	39½	Nov., 1920	1.50
Butte C. & Z	New York	4⅛	4	4	De. 9, De. 24	0.50
Butte & Superior	New York	8⅛	8⅛	8⅛	Se. 16, Se. 30 Q	0.50
Callahan Zn-Ld	New York	1⅜	1⅛	1⅛	Dec., 1920	0.50
Consol. Lead&Zinc'A'	St. Louis	11⅛	11⅛	11⅛	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	24	23⅝	24	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati			117½	Jn.30, Oc.15 Q	1.50
New Jersey Zn	N. Y. Curb	187	183	185	Oc.20, No.10 Q	2.00
United Zinc	N. Y. Curb			*55		
Yellow Pine	Los Angeles	*32½	*30	*32½	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York			1¼		
Argonaut	Toronto	*48	*40½	*42		
Barry-Hollinger	Toronto	*97	*90	*91½		
Con.W.Dome L.new.	Toronto	*18½	*15½	*16¼		
Cresson Consol. G	N. Y. Curb	1⅝	1⅜	1⅝	Se. 30, Oc.10 Q	0.10
Dome Mines	New York	11⅝	9⅞	10⅜	Se.30, Oc.20 Q	0.75
Golden Cycle	Colo.Springs	†1.79	†1.77½		Au.30, Se.10 Q	0.04
Hollinger Consol.	Toronto	17.85	17.25	17.25	Oc. 19, No. 4	0.10
Homestake Mining	New York			66½	Oc.20, Oc. 25 M	0.50
Kirkland Lake	Toronto	2.70	2.40	2.44		
Lake Shore	Toronto	27.50	27.20	27.40	Se.1, Se.15 X	0.20
McIntyre-Porcupine	New York	28⅜	28¼	28½	No.1, De.1 Q	0.25
Portland	Colo.Springs	†*24	†*20½		Ap.6, Ap.15, Q	0.02
Rand Mines	New York			48½	Au.22-29 Am.Sh.	1.52
Teck-Hughes	Toronto	11.15	10.39	10.43	Jy.21, Au.1	0.10
Tom Reed	Los Angeles	*42½	*42½	*42½	Dec., 1926	0.02
Tough-Oakes	Toronto	*63½	*53	*58		
United Eastern	N. Y. Curb	*45	*45	*45	July, 1924	0.05
Vipond Cons	Toronto	*64	*60	*61½	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	8.00	7.40	7.50	Oc.17, No.1	0.05
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	12	12	12		
Con. Cortez	N. Y. Curb	*23	*20	*23		
Dolores Esperanza	N. Y. Curb			*48	July, 1923	0.05
Premier Gold	N. Y. Curb	2⅜	2⅛	2⅛	Se.15, Oc. 4	0.08
Tonopah Belmont	N. Y. Curb	1⅛	1⅛	1⅛	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*51	*21	*21	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	1⅞	1⅞	1⅞	Se.20, Oc.21	0.07½
West End Consol.	N. Y. Curb			*7	Mar., 1923	0.05
Yukon Gold	N. Y. Curb			*44	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	1.91	1.78	1.79	May, 1920	0.03
Castle-Trethewey	Toronto	*95	*75	*83		
Coniagas	Toronto	5.00	4.80	4.80	May, 1924	0.12½
Keeley	Toronto	*85	*79	*85	Se.1, Se.15	0.08
Lorrain Trout Lake	Toronto			*60	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*18	*17	*17½	Oct., 1920	0.03
Mining Corp. Can.	Toronto	4.05	3.70	3.95	Jn. 29, Jy.15	0.12½
Nipissing	N. Y. Curb	7⅞	6½	7½	Se.30, Oc.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3¼	3⅛	3⅛	Ma. 25,Ap.4,QX	0.12½
Bingham Mines	Boston	58	57	57	Se.24, Oc.5 Q	1.00
BunkerHill&Sullivan	N. Y. Curb	136	133	135	Jy. 30, Au.4 X	0.75
Cardiff M. & M	Salt Lake	1.85	1.02½	1.25	Feb. 5, 1927	0.10
Chief Consol.	Salt Lake	2.10	2.00	2.00	Nov., 1926 Q	0.10
Consti'nMng.&Mill'g	Spokane	*20	*15	*15		
Erupcion	Boston Curb	*62	*62	*62	Se. 15, Oc.3 Q	0.07½
Eureka Lily	Salt Lake	1.35	1.15	1.30		
Federal M. & S	New York	126	126	126	Jn.25, Jn.29	Spec. $10
Federal M. & S pfd.	New York	94	94	94	Au. 25, Se.15 Q	1.75
Hecla Mining	N. Y. Curb	16½	16	16	Au. 15 Se 15 Q	0.25
Highland-Surprise	Spokane	*11½	*11	*11		
Iron King Mining	Salt Lake	*51	*49	*51		
Keystone Mining	Salt Lake			*21	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*32½	*32	*32		
Lucky Tiger-Com	Kansas City	†6.95	†6.80		Oc.10, Oc. 20	0.05
Mammoth Mining	Salt Lake	1.55	1.55	1.55	Jn.10, Jn.20 Q	0.05
Marsh Mines	Spokane	*75	*75	*75		
North Lily	Salt Lake	3.25	2.75	3.00		
Park Utah	New York	7⅞	7⅛	7⅛	Se. 15, Oc. 1 Q	0.20
Plutus Mining	Salt Lake	1.55	1.50	1.50	Jy. 10, Jy. 15 Q	0.10
San Rafael	San Fran.	*7½	*7½	*7½		
Silver King Coal	Salt Lake	9.25	9.10	9.25	Se. 20, Oc. 1 Q	0.25
Silversmith	Spokane	*14⅜	*14	*14	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*49½	*45	*49½		
Sunshine M. Co.	Spokane	1.30	1.25	1.25		
Tamarack-Custer	Spokane	*27½	*23	*27½	Sept., 1924	0.25
Tintic Standard	Salt Lake	12.00	12.00	12.00	Se.15, Se.29 QX	0.40
Utah-Apex	Boston	5	4⅛	4⅜	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	56	51⅜	51⅝	Se. 2, Oc. 1,	1.75
Cleveland-Cliffs Iron	Cleveland	101	95	100	Oc. 15, Oc. 25 Q	1.00
Colorado Fuel & Iron	New York	83½	77	78	May, 1921	0.75
Gt. North'n Iron Ore	New York	25⅛	22½	22½	Dec. 6, Dec. 28	0.75
Inland Steel	New York	52	50	50½	Au. 15, Se. 1 Q	0.62½
Replogle Steel	New York			12½		
Republic I. & S.	New York	62½	56¼	56⅜	No. 15, De.1 Q	1.00
Republic I. & S. pfd.	New York	103¼	100¾	100¾	De. 14, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	121	115	115	Se. 10, Se. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	105½	105¼	105¼	Se. 20, Oc. 1 Q	1.75
U. S. Steel	New York	147½	138	138¼	Au. 30, Se. 29 Q	1.75
U. S. Steel, pfd.	New York	137¾	136⅜	137	Au.1, Au. 30 Q	1.75
Virginia I. C. & C.	New York	40	39¾	40	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York			60½	Ju. 15, Jy. 1	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York			27⅞	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb			3		
Alum. Co. of Amer.	N. Y. Curb	97	96½	96½		
Alum. Co. of Amer.pf.	N. Y. Curb	104	103½	104	Se. 15, Oc 1 Q	1.75
Vanadium Corp.	New York	54⅜	51½	51½	No. 1, No. 15 Q	0.75
Patino M. & E.	New York	20⅛	20	20	Ap. 27, My. 5	1 sh.
ASBESTOS						
Asbestos Corp.	Montreal	39⅛	36	37	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	96	95	95	Se.30, Oc.15 Q	1.75
SULPHUR						
Freeport, Texas	New York	91⅜	85	85½	Oc.15, No.1 QX	1.50
Texas Gulf	New York	76⅛	67½	67½	Ju. 1, Ju. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	42	41½	41½	Au.20, Se.1 Q	0.75
Amer. Metal, pfd.	New York			110	Au.22, Se.1 Q	1.75
Amer. Sm. & Ref.	New York	168	158	158	Oc.14, No. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	129¾	128⅜	129	No., Dec. Q	1.75
Consol. M. & S.	Montreal	266	249	250	Jn. 30, Jy. 15 X	6.25
Newmont Mining	N. Y. Curb	104	96⅞	100	Se.30, Oc.15 Q	1.00
U. S. Sm. R. & M.	New York	38⅜	37	37	Oc. 6, Oc. 15 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	49½	49	49	Oc. 6, Oc. 15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED OCT. 11, 1927

Name	High	Low	Last	Date	Amount	Last Div.
Aramayo Mines (25 frs.)	75/3	72/6	75/—	Aug., 1927	5	p.c. (†)
British Platinum (£1)	1/—	—/3	—/3	Feb., 1925	2½	p.c.
Burma Corpn. (10 rupees)	13 —	12/6	12/7½	Aug., 1927	6	annas*
Bwana M'Kubwa (5s)	5/4½	4/9	5/1½			
Camp Bird (2s)	5/9	3/1½	3/6			
El Oro (£1)	3/9	3/4½	3/9	Nov., 1924	2½	p.c.*
Esperanza (10s)	—/2	—/2	—/2			
Frontino & Bolivia (£1)	14/4½	13/3	14/—	July, 1927	5	p.c.
Mexican Corpn. (£1)	7/6	6/3	7/6			
Mexico Mines of El Oro (£1)	15/—	13/9	15/—	Dec., 1926	3½	p.c.*
N'Changa Copper Mining	8/1½	7/6	7/6			
Oroville Dredging (£1)	5/7½	5/3	5/6	Dec., 1923	3½	p.c.
Ouro Preto (£1)	2/6	2/3	2/6	May, 1925	2½	p.c.
Rhodesian Congo Border (£1)	38/9	32/6	32/6			
St. John del Rey (£1)	10/10½	10/1½	10/9	May, 1927	3½	p.c.
San Francisco Mines (10s)	27/9	26/10½	27/—	July, 1927	15s.	
Santa Gertrudis (£1)	18/—	16/4½	17/7½	July, 1927	7½	p.c
Selukwe (2s. 6d.)	7/6	7/1½	7/6	April, 1917	6¾	p.c
S. Amer. Copper (2s.)	2/3	1/9	2/—	Nov., 1917	75	p.c.
Tanganyika (£1)	74/—	60/—	61 3	Aug., 1927	7½	p.c.
Union Miniere du Haut-Katanga (Brussels)	9.850	9.650	9 650	July, 1927	182.60	(‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.

Industrial Progress

Classification of Fire Clay Shapes Marks Progress

THE renaissance in the refractories industry takes definite form in the publication of a report by the classification committee of the American Refractories Institute. The report comprises a set of rules and formulas adopted by the Institute and is entitled "Classification of Fire Clay Shapes Other Than Straight Tile." This code places upon a commonly accepted basis the methods of determining costs of all special firebrick shapes. It is the cumulative result of more than fifteen years' work of individual members of the classification committee, as well as of many months' deliberation of the committee as a whole. The committee, composed of representatives of all important producing areas in the eastern half of the United States, has had free access to the costs of manufacturers in the several producing districts, and its conclusions are thoroughly representative.

Mechanically, the classification leaves nothing to be desired, the Institute declares. Each rule and formula is definitely laid down in easily understood language, and once it has been established, one or more illustrative examples are given to insure its proper interpretation. With the eight general rules established, every shape — from the simple arch, key, or wedge to the intricate notched and hollow forms — is classified in accordance with twelve distinct groups. As in the general rules, the classification rule is clearly stated for each group, followed again by illustrative examples.

The new code fills a need which has long existed, the Institute claims, and places the buying and selling of special firebrick shapes upon a sound, scientific basis. There is now no excuse for the manufacturer to lose money on an order for special shapes of fire clay brick, nor for the buyer to pay an exorbitant price through ignorance of the production costs.

The classification committee's report typifies the aims and purposes of the American Refractories Institute, which was organized in April, 1925, to take the place of the Refractories Manufacturers' Association, which was purely a trade association, with its activities largely commercial in character and its membership confined exclusively to manufacturers of refractories. The Institute, on the other hand, was founded primarily for scientific ends, with membership open to users as well as makers of refractories, the thought being that the problems of the industry would be more readily solved through discussions in which the producing and consuming views could be expressed. The research activities of the old association through a fellowship at the Mellon Institute of Industrial Research, University of Pittsburgh, have been maintained and enlarged through co-operative efforts with the Bureau of Standards and with colleges having scientific departments.

Copies of the report may be obtained by writing to the American Refractories Institute, Oliver Building, Pittsburgh, Pa., or to any firebrick manufacturer.

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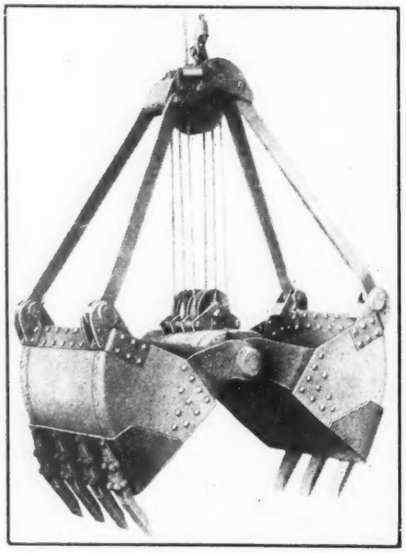
Two New Clamshell Buckets Show One-Piece Crosshead

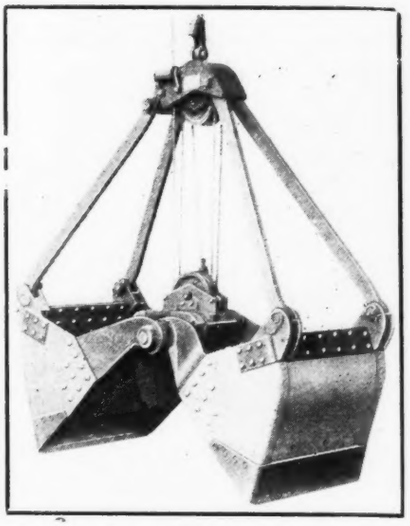
TWO new models, Type "M," a digging bucket, and Type "K," a rehandling bucket, have been recently announced by the Owen Bucket Co., Cleveland, Ohio, as replacing its older type models known as "O" and "J." Type "M," shown in the upper right corner, is made in three models—standard, special, and narrow, and Type "K,"



The new bucket with digging teeth

shown above, is made in three models—standard, special, and the high speed; the illustration shows the high-speed model, in which there is an exceptionally sharp pitch to the bottom plates to aid in rapid handling of the materials.

A new design of crosshead in one piece having seventeen fewer parts than on any previous type of Owen bucket is an important feature and makes it possible to shorten the arms and to provide for operation in reduced headroom. Provision is also made for complete protection and lubrication of the main or center shaft bearing, which has double the bearing area of the older types.



The bucket equipped for rehandling

Extra heavy special-alloy steel lips extending up the side plates past the wearing point are used. In addition, the elimination of extra thickness of angles at the corners of the cutting edges insures deeper pentration.

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Protection for the Foot

A metal foot guard, designed to protect the foot from being crushed or otherwise injured, has been introduced by the Ellwood Safety Appliance Co., Ellwood City, Pa. The "Sankey" guard, as it is named, rests on the shoe, fitting over the toes and instep. The wearer walks on the sole of his own shoe, but has the protection of this toe cap, which is attached to the foot by straps. The cap itself is made either of 16-page special steel or of an aluminum alloy, and is corrug[illegible] strength. Made of steel it weighs 16 oz., and of the aluminum [illegible]z.

TRADE CATALOGS

FLOTATION—Denver Equipment Co., Denver. Bulletin 2701. Denver "Sub-A" Fahrenwald flotation machine. Pages 16, illustrated.

COMPRESSORS — Gardner-Denver Co., Denver. Bulletin 200-A. A new line of portable compressors. Pages 16, illustrated.

CRUSHERS—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1827. Superior jaw crushers. Pages 12, illustrated.

STEEL PRODUCTS—Sheet Steel Trade Extension Committee, Oliver Building, Pittsburgh. A directory entitled "5,000 Sheet Steel Products and Who Make Them." Pages 445.

INDICATORS—Brown Instrument Co., Philadelphia. Folder on automatic control of temperature and pressure.

COMPRESSORS—General Electric Co., Schenectady, N. Y. Bulletin GEA-233A. Centrifugal air compressors, single stage. Pages 4.